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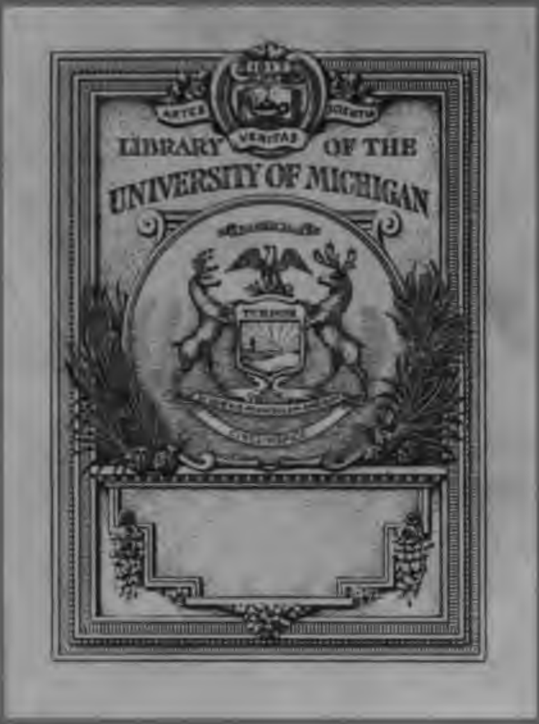

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THE

Philoſophical Works

Of the HONOURABLE

ROBERT BOYLE Eſq;

Abridged, methodized, and diſpoſed under the
GENERAL HEADS
OF

PHYSICS,	NATURAL HISTORY,
STATICS,	CHYMISTRY, and
PNEUMATICS,	MEDICINE.

The whole illuſtrated with NOTES, containing the *Improvements* made in the ſeveral *Parts* of natural and experimental *Knowledge* ſince his time.

VOL. III.

By *PETER SHAW*, M. D.

LONDON:
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TO
The Right Honourable
The Lord *Shannon*.

MY LORD,

SUCH was the merit of the Honourable Mr. *Boyle*, ſuch his abilities and public ſpirit, that, perhaps, no man ever deſerved a greater, or bore a fairer character. The honour he reflects upon his noble family and your Lordſhip, is worthy of that he derives from thence. Never were a polite education and a philoſophical genius improved more to the advantage of mankind, to private ſatisfaction and true glory, than by the great Mr. *Boyle*; that noble example for the imitation of men of plentiful fortunes, and a philoſophical taſte, in laying out their lives to their own and the pub-

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lic advantage. And whence can we with more juſtice expect, or whence more frequently ariſe, ſuch bright examples, than from your Lordſhip's noble family, which inherits the virtues that have render'd the name of Mr. *Boyle* ſo deſervedly famous?

The two former volumes of the abridgment of his incomparable philoſophical writings being put under the protection of competent judges; this third begs your Lordſhip's acceptance; that the whole may be ſubmitted to ſuch as know to ſet a juſt value upon philoſophical merit, and have a natural and tender regard for the original author.

I am,

May it pleaſe your Lordſhip,

Your Lordſhip's moſt humble,
moſt obedient,
And moſt devoted Servant,

Peter Shaw.

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NATURAL HISTORY.

THE

PREFACE.

Natural hiſtory ſeems at preſent to lie under ſome diſgrace, upon account of the ſmall benefit that is preſumed to ariſe from the ſtudy of it. And, indeed, if a notion be formed of the whole thereof, from a few of its parts which have been dryly treated by ſome virtuoſi, a rigid philoſopher might be apt to condemn it as trifling and almoſt uſeleſs to mankind. A real philoſophic genius, bent upon its own improvement, ſees with indignation, the life of a virtuoſo ſpent among ſhells and inſects; and wiſhes the ſame time and application laid out to nobler purpoſes. Theſe things, however, have their uſe; and we ought not to deſpiſe all that we our ſelves have no reliſh for. There will, and 'tis neceſſary there ſhould be men of various taſtes; and 'tis happy for the world that no part of philoſophy remains uncultivated. But if any man has a deſpicable opinion of natural hiſtory in general, let him look upon it in that view wherein Mr. Boyle *conſider'd it; for here, as in every thing elſe, our excellent author has regarded uſefulneſs and the benefit of mankind. Natural hiſtory, as managed by him, has no ſuperfluous branches; nothing that barely amuſes the mind, without gratifying and delighting it; nothing that entertains the fancy, without being ſerviceable in life: and his hiſtory of the air, his way of making ſalt-water freſh,* &c. *are eminent inſtances of it. But natural hiſtory, in its extent, he found to be a very large field, that required a great number of hands to* *be employ'd in it; and therefore, to render it as uſeful and complete as poſſible, he endeavoured to engage many of his friends in the ſtudy thereof. 'Twas his cuſtom to diſtribute all ſuch large undertakings under proper heads, and ſo diſpoſe of thoſe heads ſeparately to perſons whom he reſpectively knew well qualified to cultivate and improve them. But he found few ſuch diligent ſearchers into nature as himſelf; and therefore received little aſſiſtance in this way from his friends. Hence ſeveral parts of his ſchemes of titles remain unſpoken to; and this is particularly the caſe in the following hiſtory of the air. Mr.* Boyle, *however, performed wonders of himſelf; his inquiſitive genius lead him to abundance of particulars which eſcape the knowledge of others; and theſe he generouſly communicates. Were this practice encouraged, and were more heads and hands employ'd after the ſame manner, the world might in time ſee what Mr.* Boyle *has here laid the foundation of, a complete natural hiſtory; by means whereof philoſophy it ſelf wou'd, at length, be completed alſo.*

HEADS
FOR THE
NATURAL HISTORY
OF A
COUNTRY.

THE general heads for the natural hiſtory of a country will reſpect the heavens, the air, the water, and the earth.

The heavens.

To the firſt belong the longitude and latitude of the place, and conſequently the length of the longeſt and ſhorteſt days, the climate, parallels, and the viſible fix'd ſtars; with the conſtellations whereto 'tis ſaid to be ſubject.

The air.

Of the air may be obſerved its temper, as to heat, dryneſs and moiſture, with the meaſures of them; its weight, clearneſs, refractive power, ſubtilty or groſsneſs, its abounding with, or wanting an eſurine ſalt; its variation according to the ſeveral ſeaſons of the year, and the times of the day: how long the ſeveral kinds of weather continue; what ſort of meteors the air moſt commonly breeds; in what order they are generated, and how long they uſually laſt: to what winds 'tis liable; whether any of them be stated, ordinary, *&c.* What diſeaſes are epidemical, that are ſuppos'd to ariſe from the air: to what other diſeaſes the country is ſubject, in the production whereof the air is concerned. What is the uſual ſtate of the air as to the health of the inhabitants; and with what conſtitutions it agrees better or worſe than others. The gravity of the air is to be learnt by the barometer.

The water.

With regard to the water are to be conſider'd the ſea, its depth, ſpecific gravity, difference of ſaltneſs in different places, the plants, inſects, and fiſhes to be found in it, tides, with reſpect to the adjacent lands, currents, whirl-pools, *&c.* rivers, their bigneſs, courſe, inundations, taſte, ſubterraneous paſſages, fruitfulneſs, *&c.* lakes, ponds, ſprings, and eſpecially mineral waters; their kinds, qualities, virtues, and how examin'd; the ſorts of fiſhes, their ſize and goodneſs, plenty, ſeaſons, ways of breeding, haunts, and the methods of taking them; eſpecially thoſe that are not purely mechanical.

The earth. In the earth may be obſerved it ſelf, with its inhabitants and productions, as well internal as external; its dimenſions, ſituation, eaſt, weſt, ſouth, or north; its figure, plains, hills or valleys; their extent, the height of the mountains, either in reſpect of the neighbouring valleys, or the level of the ſea; whether the mountains lie ſcatter'd or in ridges; and whether thoſe run north or ſouth, eaſt or weſt, *&c.* What promontories, fiery or ſmoaking hills, *&c.* the country has; whether ſubject to earthquakes or not. Whether the country is coherent, or much broken into iſlands. What declination the magnetic needle has in ſeveral places at the ſame time; and how much it varies in different times at the ſame place: whether before hurricanes, the needle loſes its direction towards the north; and turns equally to all the points of the compaſs. The nature of the ſoil, whether of clay, ſand, gravel, *&c.* its peculiar qualities, and productions, as to minerals, vegetables and animals: and how all theſe are or may be farther improved for the benefit of man.

Inhabitants. Under inhabitants are to be conſidered both the natives and the ſtrangers who have been long ſettled there; particularly as to their ſtature, ſhape, features, ſtrength, ingenuity, diet, inclinations and cuſtoms, that ſeem not due to education. In the women, their fruitfulneſs or barrenneſs, their eaſie and hard labour, with their exerciſes and diet; the diſeaſes, with their ſymptoms, and the diet, air, *&c.* that influence them.

Vegetables. The external productions are trees, fruits, plants, *&c.* with the peculiarities obſervable in them. In what ſoils, and with what culture they thrive beſt; with what animals or inſects the country abounds, and to what uſe applied by the inhabitants, as to food, phyſic, ſurgery, *&c.*

Minerals. By the internal productions of the earth are here underſtood things generated in the bowels of it, either to the benefit or hurt of man. Under theſe are comprehended metals, minerals, ſtones, precious or common. To examine how the beds of them lie in reference to north or ſouth, *&c.* What clays and earths are afforded, with their the phyſical or other uſes; what coals, ſalts, or ſalt-ſprings, alum, vitriol, ſulphur, *&c.* The number of mines, their ſituation, depth, ſigns, waters, damps, quantities of ore, extraneous things, and ways of reducing their ores into metals, *&c.*

Traditions. Add to theſe the inquiries about traditions of all particular things relating to the country, ſuch as are either peculiar to it, or at leaſt uncommon elſewhere.

Enquiries that require learning or ſkill to anſwer; with propoſals for ways to enable men to give anſwers to ſuch more difficult enquiries.

Inquiries for the ſea.

To obſerve the declination of the compaſs in different longitudes and latitudes; ſetting down the method by which the obſervation was made.

To obſerve the dipping-needle, in the like manner.

To obſerve the odour, colour, and taſte in ſea-water; the proportion of its ſalt in different places; whether in the ſame ſea it be conſtantly the ſame; and what are the particularities of that ſea-water, where ſhips cables ſooneſt rot, and where they are beſt preſerved.

To remark, if there be near the ſouth pole a conſtant current, ſetting from the ſouth ſo forcibly, that ſhips with a ſtiff gale can hardly make way againſt it; and near the north, a current forcibly carrying ſhips towards the pole; or if this motion reciprocate once in half a year.

To obſerve what ſubterraneous paſſages there are, whereby ſeas communicate with one another.

What effect the winds have upon the ſeas; and how far from the ſurface they agitate the waters.

The ebbings and flowings, with the age of the moon when the neap and ſpring-tides happen; to what height it ebbs and flows at theſe times upon the coaſt, or the iſlands far off in the ſea; and if it flow there differently from the tides near the main land; and how much ſooner it begins on one ſide than another.

To mark narrowly the way of coming into particular creeks and harbours; with their bearings and diſtances from the neighbouring places.

To ſound all along at coming in; and to mark the depths and ſhallows near the ſhoar, or farther off from the coaſt, as alſo near ſhelves or banks.

To mark in the ſounding not only the depth, but all the grounds, whether clayie, ſandy or ouſie, *&c.* To mark whether the ſea always riſes towards the ſhore, unleſs accidentally hindered. How the bottom of the ſea differs from the ſurface of the earth; with the ſtones and minerals to be found there.

To take notice of the winds, their changes, or ſet times of blowing, and in what longitude and latitude, eſpecially the trade-winds; upon what coaſt the trade-winds are moſt frequent; and by what ſigns they may be foreſeen.

To obſerve and record all extraordinary meteors, lightnings, thunders, and their effects, *Ignes fatui,* comets, *&c.* marking the places of their appearing and diſappearing.

To examine the weights of the ſeveral waters that occur, both near the upper and lower part of the ſea; the power aſcribed to the ſea of throwing up amber, ambergreece, *&c.* and its ſhining in the night.

The medicinal virtues of the ſea; eſpecially in the hydrophobia. Its virtue to manure land; and to learn what plants thrive beſt with ſea-water.

Inquiries for mines.

Whether the country wherein the mines are, be mountainous, plain, or diſtinguiſh'd with valleys? And in caſe it be mountainous, what kind of hills are they, whether high, low, or indifferently elevated? Whether almoſt equal, or very unequal in height? Whether fruitful or barren; cold or temperate; rocky or not; hollow or ſolid? Whether they run in ridges, or ſeem confuſedly plac'd; and if the former, what way the ridges run, north or ſouth, &c? and whether they run nearly parallel to one another?

What the country produces, and what in moſt plenty?

What cattle it ſuſtains? Whether they have any thing peculiar in point of bigneſs, colour, longevity, fitneſs or unfitneſs for food, *&c.* which may rather be attributed to the peculiar nature of the place, than the barrenneſs of the ſoil, or other manifeſt cauſes?

What health the inhabitants enjoy? What diſeaſes they are ſubject to, and to what not? And what remedies are known for the epidemic diſeaſes of the place?

What plenty of rivers, brooks, lakes, ſprings, *&c.* in the place; the colour, taſte, *&c.* of them; and how they affect the health of ſuch as uſe them?

How the air is diſpoſed as to heat or cold, calms or winds; and whether theſe winds proceed from, or are infected with ſubterraneous ſteams? Whether theſe ſteams are clear, or foggy?

Whether the ſoil near the ſurface of the earth be ſtony; and if ſo, what ſort of ſtones it abounds with; whether the ſoil be clayie, marly, or chalky; and of how many kinds it is; and by what properties they are diſtinguiſh'd?

By what ſigns a mine is conjectured to be in a place?

And as theſe ſigns are either above or beneath the ſurface of the earth, it muſt be farther inquired whether the ground be made barren by metalline or mineral effluvia?

What trees or plants grow moſt plentifully in theſe places, and whether they thrive well or ill? Whether they be diſcolour'd in their leaves, or have their outſides chang'd?

What alteration is produc'd in the waters of the place, either as to their colour, taſte, ſmell, weight; or what matter they leave upon the ſtones they run over?

Whether ſnow or ice continue as long in theſe as in the neighbouring places?

Whether the dew that falls on the ground will diſcolour white linen? And whether the rain will diſcolour cloaths, or afford any reſidence of a mineral nature?

Whether thunder, lightnings and ſtorms are frequent here? And if there be any fiery meteors and nocturnal lights?

Whether miſts ariſe from ſuch mineral grounds; what is obſervable in them; what minerals they ſignifie, and may be ſuppos'd to be produc'd by?

Whether the *Virgula divinatoria* be us'd for finding out the mines, and with what ſucceſs?

Whether there be any clays, marles, or other mineral earths, and of what conſiſtence, that give notice of the ores; and at what depth they lie, in reſpect of one another, and how thick they are?

What ſtones, marcaſites, *&c.* are found near the ſurface; what is the particular ſhape, bigneſs, colour and weight of ſuch ſtones, whereby they are diſtinguiſhable from others?

Whether heat or damps ſignify a mine?

Whether water found in digging be a ſign of a mine?

By what ſigns the nearneſs of a mine is known; and whether any ſign will ſhew a perſon to be above, beneath, or on the ſide of the mine?

By what ſigns the determinate kinds of metals are known, with their plenty and goodneſs?

What ſigns there are of the depth of the vein; of the mine's being hopeleſs, or that 'tis unlikely to find a vein in the place 'tis digged for?

What is the depth of the ſhaft or groove, till you come at the vein or ore; whether the vein run or lie horizontally; or if it dip, what inclination it hath; and how deep the loweſt part lies?

What are its flexures, or whether it runs directly north or ſouth, eaſt or weſt, or ſeem rather to have a caſual tendency than any natural determination; and how far it reaches in all?

What is the wideneſs of the groove at the top and elſewhere; whether it be perpendicular or crooked; and if crooked, after what manner, and with what diſtance it winds?

How the groove is ſupported; what the kinds, length, bigneſs, and way of placing of the timber, poles, *&c.* employ'd to ſupport it; and how long the wood continues, without being ſpoil'd by the ſubterraneous fumes and waters; and what wood laſts the longeſt?

What air-ſhaft belongs to the mine; whether it be ſingle or double, of what breadth at the orifice; whether it be convenient or not; how near 'tis plac'd to the groove, and in what poſition; if there be ſeveral air-ſhafts, what their diſtances and ſituation with regard to the groove, and to each other; and how is air ſupply'd, if there be no air-ſhafts?

Whether they meet with waters, and what plenty there is of them; at what depth they are found; how qualified, and what way they ſpring, *&c*?

Whether they are conſtant or temporary; whether they increaſe or diminiſh in the ſummer, or at any time of the year; and what that ſeaſon is, how long it laſts, and the proportions of increaſe and decreaſe?

What engines or contrivances are uſed for drawing up the water, and conveying it away; the materials they are made of, the parts, the bigneſs, the coaptation, and whole ſtructure, and way of applying the inſtruments uſed to free the mines from the water?

What are the conditions, number, &c. of the adits?

Whether the mines be troubled with damps, and of what kind they are; whether they come often or ſeldom, at any Time of the year, or irregularly?

What ſigns precede them; what miſchief they do; what remedies are the moſt ſucceſsfully employed againſt them, as well in reference to the clearing of the mine, as to the preſervation and recovery of the men?

What methods the mine-men uſe in following the vein, and tracing their paſſages under ground, according to the ſeveral exigencies; and whether they employ the inſtruments made with the help of the loadſtone, the ſame way that is uſual; and, if not, wherein they differ in the uſe of the ſame inſtruments, or what they ſubſtitute in their place?

By what means they ſecure themſelves againſt the uncertainty whereto the magnetical needle is ſubject, when it comes near iron ore; and what other means may be uſed, beſides a load-ſtone, to help a miner?

How the miners deal with the rock and ſpar they meet with, before they come at the ore; and how they uſe fire to ſoften, calcine, or crack them, and with what ſucceſs?

By what means they free the mines and the workmen from the inconveniencies ariſing from the great uſe of fire?

With what inſtruments they break the rock; how they are conducive, and how long they laſt?

How the miners work, whether cloathed or naked; what lights they uſe; what materials they are made of; and what meaſure of illumination they afford; how long they laſt, and by what ways they are kept burning in that thick and foggy air?

How veins are followed, loſt, and recover'd; and how ſeveral miners work on the ſame vein; and what is the beſt way of getting all the ore in a vein, and that moſt conveniently?

How they convey out their ore, and other things that are to be carried up; what kind of veſſels they uſe for matter, ſhape and capacity, and whether the workmen deliver them one to another, or the ſame workmen carry them all the way; and whether they deſcend and aſcend by ladders of wood or ropes, &c?

Whether the ore runs in a vein, or lies diſpers'd, or be divided partly into a vein, partly into looſe maſſes, or like a wall between two rocks, as it were in a cleft; or be interſpers'd in the firm rock, like ſpeckled marble; or be found in grains, like ſand or gravel; and what is obſervable in it as to weight, colour, mixture, &c?

Whether any part of the metal be found in the mine perfect and complete?

Whether the mine affords any parcels of metal that ſeem to grow like plants?

Whether the vein lie near the ſurface of the earth, and at what depth; whether it have any peculiar concomitants or coats; and if any, what they are, and in what order they lie? Thus the veins of lead ore with us have frequently annexed to them a ſubſtance called ſpar, and next to that another call'd calk; and whether they have any other heterogeneous ſubſtance?

What are the principal qualities of theſe extraneous ſubſtances?

Whether the vein be incloſ'd every way in its coats, or lie only between them?

Whether the vein be every way of an uniform breadth and thickneſs; and if it be, what the dimenſions are; and if not, in what places it varies, and by what meaſures?

Whether the vein be uninterrupted, or in ſome places broken off; whether abruptly or not; and whether by vales, brooks or gullets, *&c*?

How wide the interruptions are; by what ſigns the veins may be found again; whether the farther diviſion of the vein be of the ſame nature, and hold on in the ſame courſe, as to its tendency upwards and downwards, or horizontally, northward or ſouthward, *&c.* with the vein from which 'tis cut off?

Whether, in caſe the laſt end of the vein be found, it terminate abruptly, or in ſome kind of rock or earth, which, as it were, cloſes it up, without leaving any crack, or otherwiſe; whether the terminating part of the vein tends either upwards or downwards, or neither; whether in the places where the vein is interrupted, there be any peculiar ſtone or earth that ſeals up the extremity of it?

Whether it be obſerv'd that the ore, in tract of time, may afford any gold or ſilver, which it affords not, or more than it would afford, if it were not ſo ripe; and whether it has been found that the metalline part of the vein grows ſo, that ſome part of the ore will afford metal in tract of time, that did not ſo before; and whether to this maturation of the mine, the being expoſed to the free air be neceſſary; or whether, at leaſt, it conduce to the acceleration of it, or otherwiſe?

Whether all the ore contain'd in the mine be of the ſame nature and goodneſs; and if not, what are the differing kinds, and how to be diſtinguiſh'd and eſtimated?

What is the fineneſs and goodneſs of the ore, by which the mine is uſually eſtimated; and what the marks and characters that diſtinguiſh one ſort from another?

What proportion of metal the ore affords?

Whether the ore be pure, in its kind, from other metals; and if not, of what metals it participates, and in what proportion?

What previous operations are us'd to the melting of the ore, as beating, grinding, waſhing, *&c.* and with what circumſtances; as how long the ignition laſts at a time; whether the ore be ſuffer'd to cool of it ſelf, or be quenched; whether it be waſh'd betwixt each ignition; or whether the ore requires no ſuch preparations, as it often happens in lead, and ſometimes in iron?

NAT.HIST.

Whether mercury is made uſe of in ſeparating the nobler from the baſer metals?

Whether the ore be expos'd to the air, as a preparative?

What flux-powders they uſe to examine their ores in ſmall quantities?

Whether in reducing or melting great quantities they uſe any flux-powder; what it is, and how employed?

What is the contrivance of the furnaces, and if they be all of one, or of differing ſorts or bigneſs?

What tools are uſed in ſmelting, and how contriv'd?

What fewel they uſe, and how much is ſpent in a day; and what returns they have of metal, in a proportionate time?

Whether the ore be melted by means of a wind, made by the fire's own motion, by water, or by bellows; if the latter, what their dimenſions are, and what way us'd?

What way they take to let out the metal that is in fuſion, to caſt it into bars, ſows, pigs, *&c.* and what clay, ſand, or mould they let it run through; and after what manner they cool it?

Whether to facilitate the fuſion, they mix ſeveral ores of the ſame ſort together?

Whether after 'tis once melted, they melt it again, to make it more pure; and if ſo, with what circumſtances they perform it?

Whether they have ſigns to know when the fuſion is well or ill perform'd, and that the metal has obtain'd a perfection requiſite in ſuch a fuſion, and ſuch a furnace?

Whether they obſerve any difference in the goodneſs of the metal that comes firſt, from that which comes laſt; and whether the rule holds conſtantly?

Whether the produc'd metal be all of the ſame goodneſs; and if ſo, how good it is compared with the metals of other mines, or other parts of the ſame vein; and if it be not, what differences are between the produced portions of metal, and what diſparity that makes in the price?

What are the ways of diſtinguiſhing them, and eſtimating their goodneſs?

Whether flowers be not elevated to the upper parts of the chimney; and whether they are barely excrementitious or metalline?

Whether, when the ores are brought to fuſion, they have any recrements; what theſe recrements are, and how to be ſeparated from the baſer metal?

Whether, after the metal has been melted, the remaining part of the ore will, in tract of time, be impregnated with more metal?

Whether the air appears really to be cool in ſummer, and hot in winter, at the bottom of the mine, by more evident proofs than the teſtimony of our touch?

Whether they find the ſtones and ground actually hot, ſo that ſometimes they can hardly ſtand upon the place; and if ſo, from whence this proceeds?

Whether there be mineral juices in the mine that harden into ſtones or metals, upon contact with the air?

What laws, conſtitutions and œconomy are obſerv'd among the miners?

In what way the trees and their leaves are affected by the mineral fumes and juices, and if they be gilded or ſilver'd; if theſe trees be more ponderous than others; if they have any metalline or mineral concretes lodg'd in their pores?

Whether there be waters and ſprings obſerv'd to riſe near the mines, and run their whole courſe under the ground, without ever appearing above it?

Whether the ſubterraneal ſprings riſe with any wind, or determinate change of weather?

How much heavier the atmoſphere is at the bottom than at the top of the mine; and whether damps conſiderably increaſe the weight of the air?

Whether any ſtrange ſubſtances are found in the mine, as veſſels, anchors, fiſhes inclos'd in ſpar or metal, *&c?*

Enquiries particularly about cold, for Poland, *and the more northern countries.*

What is the way of making pot-aſhes?

What is to be obſerved about amber; is it an exudation of the ſea, ſoft when firſt caſt on ſhore; at what ſeaſon of the year, and in what manner taken up, *&c?*

What is to be obſerved in the digging of *Sal gemmæ* in *Poland*; and what is the depth of the mines ſtored with the ſalt; and what their diſtance from the ſea?

What truth is there in that relation, of ſwallows being found under waters congeal'd in winter, and reviving when held to the fire?

Whether there be in the *Bodnic-bay* a whirl-pool, as is related to be in the ſea of *Norway*, which is commonly called the *Maal-ſtroom*; and whether there be any ſigns of the communication of thoſe gulphs by ſubterraneous paſſages?

To what depth the cold in theſe parts reaches, in the earth and water?

Whether watches are made to go ſlower by the cold?

Whether oil, in great colds, is turned into true, hard and brittle ice?

Whether they can freeze a ſtrong brine of bay-ſalt, a ſtrong decoction of *Sal gemmæ*, ſoot, or a ſtrong ſolution of ſalt of tartar, or ſugar of lead?

Whether they can congeal meer blood without the ſerous part, *Canary* wine, ſolutions of all ſalts, and ſtrong ſolutions of metals?

Whether an intenſe and laſting froſt makes any alteration in quickſilver, expoſed very ſhallow, and in a flat Veſſel?

NAT. HIST.

Whether the purgative virtue of cathartics be increaſed, diminiſhed, or even totally deſtroyed by a ſtrong continual cold?

Whether harts-horn, and the like ſubſtances thawed, will yield the ſame quantity of ſpirits as they do when they have not been frozen?

What are the effects of cold in the fermentations of liquors?

Whether birds and wild beaſts grow white in the winter-time, and recover their native colour in ſummer?

Whether colours may be concentred by cold; for inſtance, that of a ſtrong decoction of cochineal in a fit glaſs?

Whether the electrical virtue of amber, and the attractive force of the magnet, will be changed by vehement cold?

Whether thick pieces of iron and ſteel be made brittle by intenſe froſts; ſo that ſmiths are obliged, for prevention, to give their tools a ſofter temper?

Whether accurate obſervations ſhew, that all fiſhes die in frozen waters, if the ice be not broken; or whether the cold it ſelf, or the want of changing or ventilating the water, or the privation of air, be the cauſe of their death?

Whether any ſkilful anatomiſt has enquired, by freezing ſome animals to death, after what manner it is that intenſe cold kills men; whether they have found ice in the inward parts, as the brain and heart, and in the large veſſels?

MEMOIRS
FOR A
GENERAL HISTORY
OF THE
AIR.

Heads for a general hiſtory of the air.

1. THE *conſtant ingredients of the air, or atmoſphere.*
2. *The æther in the atmoſphere.*
3. *The elaſtic particles of the air and its ſpring.*
4. *The magnetic particles of the air.*
5. *The deſtruction, generation, abſorption, and extrication of the air.*
6. *The accidental ingredients of the air.*
7. *The aqueous particles in the air, with the moiſture and dryneſs thereof.*
8. *Clouds, miſts, and fogs.*
9. *Terreſtrial ſteams in the air.*
10. *Salts in the air.*
11. *Sulphur; inflammable particles in the air; lightning and its effects.*
12. *Celeſtial influences or effluvia in the air.*
13. *The height of the atmoſphere.*
14. *The motion of the air; and winds.*
15. *The air conſider'd as the medium of ſounds. Noiſes in the air, and particularly thunder. The air's operation on the ſounds of bodies.*
16. *The weight of the air.*
17. *The conſiſtence of the air; its rarity, denſity, fluidity, and ſubtilty.*

18. *The heat and coldneſs of the air.*
19. *The air conſider'd in relation to light; its perſpicuity, opacity, reflexions, refractions, colours,* &c.
20. *The operation of the air on the conſiſtence of animal, vegetable and mineral ſubſtances.*
21. *Air conſider'd with regard to fire and flame.*
22. *Air, as it regards fermentation.*
23. *Air conſider'd as the receptacle of odours.*
24. *The air's operation on the odours of animal, vegetable and mineral ſubſtances.*
25. *The operation of the air on the taſtes of animal, vegetable and mineral ſubſtances.*
26. *The operations of the air on the colours of animal, vegetable and mineral ſubſtances.*
27. *The air conſidered as deſtroying or introducing leſs obvious qualities into animal, vegetable and mineral bodies.*
28. *Air conſider'd with regard to the propagation and vegetation of plants.*
29. *The air conſider'd with the regard to the generation, life and health of animals.*
30. *Heavy bodies ſuſtain'd by, or taken up into the air.*
31. *Dew.*
32. *Rain.*
33. *Hail.*
34. *Snow.*
35. *Unuſual things falling out of the air.*
36. *Miſcellaneous experiments and obſervations on the air.*
37. Deſiderata *in the hiſtory of the air; with propoſals to ſupply them.*

Definition of the air.

AIR here ſignifies the thin, tranſparent, compreſſible and dilatable fluid, wherein we breathe and move, that ſurrounds the whole ſurface of the earth to a conſiderable height, and differs from the æther in refracting the rays of the celeſtial luminaries.

The air may be conſidered both as tranſient and permanent. For example, if an æolipile of water be ſufficiently heated, and ſuffer'd to expel the particles of air by its aqueous vapour, this will afterwards be forcibly driven out in a large quantity, like the blaſt of a pair of bellows, and occaſion a ſharp, whiſtling noiſe againſt the edge of a knife conveniently held thereto. Yet ſuch a vapour, tho', whilſt the motion laſts, it reſembles air, ſoon loſes that reſemblance, eſpecially in the cold, and returns, by condenſation, to its original water.

Ingredients of the air.

Many are the experiments I have made upon the air, but farther trials appear neceſſary to determine its nature. I conjecture, however, that the atmoſpherical air conſiſts of three different kinds of corpuſcles; the firſt, thoſe numberleſs particles which, in the form of vapours or dry exhalations, aſcend from the earth, water, minerals, vegetables, animals, *&c.* in a word, whatever ſubſtances are elevated by the celeſtial or ſubterraneal heat, and thence diffuſed into the atmoſphere. The ſecond may be yet more ſubtile, and conſiſt of thoſe exceedingly minute atoms, the magnetical effluvia of the earth, with other innumerable particles ſent out from the bodies of the celeſtial luminaries, and cauſing, by their impulſe, the idea of light in us. The third ſort is its characteriſtic and eſſential property, I mean permanently elaſtic parts. Various hypotheſes may be framed relating to the ſtructure of theſe latter particles of the air. They might be reſembled to the ſprings of watches, coil'd up and endeavouring to reſtore themſelves; to wool, which being compreſſed, has an elaſtic force; to ſlender wires of different ſubſtances, conſiſtences, lengths and thickneſs; in greater curls or leſs, near to, or remoter from each other, *&c.* yet all continuing ſpringy, expanſible and compreſſible. Laſtly, they may alſo be compared to the thin ſhavings of different kinds of wood, various in their lengths, breadth and thickneſs. And this perhaps will ſeem the moſt eligible hypotheſis; becauſe it, in ſome meaſure, illuſtrates the production of the elaſtic particles we are conſidering. For no art or curious inſtruments are required to make theſe ſhavings, whoſe curls are in no wiſe uniform, but ſeemingly caſual; and what is more remarkable, bodies that before ſeem'd unelaſtic, as beams and blocks, will afford them. Hence alſo we may perhaps fetch an illuſtration of ſome experiments, wherein I found that various, ſolid, and mineral bodies, unſuſpected of elaſticity, being plunged in corroſive unelaſtical menſtrua, will, upon a proper comminution of their parts, afford in the conflict a conſiderable quantity of permanently elaſtic air. But many other figures, and ſome perhaps more proper, may be attributed to theſe elaſtic corpuſcles.

All I ſhall add is, that tho' air ſeem to continue elaſtic, upon account of its ſtructure, rather than any external agitation, yet heat, which is a kind of motion, may make the agitated particles endeavour to recede from the centres of their motion, and to repel thoſe that would hinder their free rotations; and thus greatly add to the attempt it makes towards expanſion. And by this means there may perhaps be mixed with the ſpringy particles, others whoſe elaſticity is owing more to their motion than their ſtructure; that variouſly whirling them, ſo as to remove the adjacent corpuſcles, and thereby promote an expanſive force in the air they go to compoſe. Some of theſe, indeed, may, in very cold climates and ſeaſons, prove of a like kind with what I above ſhew'd to be of a ſhort duration; yet others of them may be ſo minute, agile, and advantageouſly ſhaped, that at leaſt, in our climate, the air will be warm enough to promote its own agitation, and keep it ſelf fluid, and give a competent motion to particles ſo well diſpoſed to preſerve it.

The ſpring of the air.

“ We find that in blowing up a football the included air gradually increaſes in its reſiſtance, and not only thus oppoſes its own condenſation, but alſo endeavours to expand it ſelf. Whence we are furniſhed with a method of making fountains to play, and of ſhooting off bullets by the ſpring of the included air. But becauſe 'tis difficult to compreſs air to any conſiderable degree with the natural ſtrength, 'twill be proper to apply the skrew to that office, in the following manner.

Figure 1.

Suppoſe for a fountain, the metalline veſſel ABE, made concave at the top, with a hole A, for the water to enter at; which, running in, will force out the air thro' the open tube CD. Before the veſſel is filled, let the hole A, be cloſe ſtopped with a skrew, and turn the ſtop-cock, E, to cloſe that end. Place next a little bucket on one ſide within the veſſel, with its embolus HI, whoſe upper part muſt be fixed to the moveable ear of the veſſel. The embolus HK, being perforated quite thro', ſhould have a valve fix'd to it at the hole S, to hinder the air, there ſent out, from returning; and the like is to be done externally at the bottom of the bucket, I. Let the cylindrical ſurface of the embolus be cut into a male skrew, and fitted to a female one in the plate MN, which may be faſtened externally as a prop to the ear of the veſſel, by means of two ſmall skrews in M, and N. When the water is in, theſe ſmall skrews M, and N, are to be looſened, and the plate to be raiſed from the veſſel up to the handle HO, whereby the embolus being drawn out, the air paſſes thro' the perforation HS, to fill the bucket; and upon thruſting the embolus down, the valve at S, is ſhut, and the air forced out at the bucket thro' the valve I, into the veſſel, whence it can neither eſcape nor force out the water; both the ſtop-cock and hole at A, being ſhut; conſequently it is condenſed; and at a ſecond elevation of the embolus endeavouring to expand it ſelf, the valve I, is thereby forcibly preſſed againſt the hole in the bucket, and that paſſage blocked up. When, by repeated ſtrokes, ſo much air is forced in, as cauſes the embolus to go very ſtiff, the plate MN, is again to be skrewed on; and the pump may be further work'd, by taking hold of the handle in O, and gradually revolving the embolus backwards and forwards, by means of its skrews, till the air is very ſtrongly compreſſed, when opening the ſtop-cock E, the water will fly out at the tube CD, at firſt with great vehemence, but leſs forcibly by degrees, as the elaſticity of the air grows leſs. The like contrivance will, alſo, proportionably ſerve in wind-guns, which may alſo be made without any thing to receive the compreſſed air, after the manner of the elder pot-guns, uſed by children, with their paper pellets. For a long concave cylindar of iron being procured, two leaden bullets, by means of paper, or the like, may be exactly fitted to its

" bore; ſo that if a female skrew were cut on the internal ſurface of " one end, whereto the male skrew cut on a ſolid cylindar of the ſame " metal anſwered, which being a little ſhorter in length, and made " to move in the other by a force applyed to a proper handle, till all " the air contained in the cavity was condenſed into a narrow com- " paſs between the two bullets, the foremoſt of them would be thereby thrown out of the tube with a prodigious force. " *Caſatus.*

Experiment 1. We put ſome copper filings, with a mercurial gage, into a conical cryſtal glaſs exactly fitted with a ground ſtopple, and poured upon the filings as much rectified ſpirit of fermented urine as roſe an inch above them; then carefully ſtopping the glaſs, we ſeveral hours after perceived that the mercury in the ſealed leg was conſiderably depreſſed; when letting in the external air, we found it to have a manifeſt effect upon the mercury.

Experiment 2. Into a like glaſs we put more copper filings, and poured thereon ſtrong ſpirit of putrefied urine, till it roſe about an inch above them, and having let down a mercurial gage, ſo that it reſted againſt the bottom and ſide of the glaſs, we cloſed it with a ſtopple, and ſet it in a quiet and well illumin'd place; having firſt obſerved the ſtation of the quickſilver in the gage. The menſtruum work'd very calmly upon the filings, gradually acquiring a very pleaſant blue colour, and the glaſs being kept at reſt in the ſame place for two or three days longer, the liquor began to loſe its colour, growing fainter by degrees, till at the end of three or four days it became very pale. Then admitting the external air, and leaving the vial in the ſame place and poſture, I found within four or five minutes the upper part of the liquor of a fine blue colour, which in ten minutes time had diffuſed it ſelf thro' the whole; ſo that in leſs than a quarter of an hour, the liquor was throughout of a rich blue colour, and in a few minutes longer grew opake. When carefully cloſing the vial again, we ſet it in the ſame place, where the liquor began again, within two or three days, to loſe its colour; ſo that I made a ſecond experiment much like the former. The like ſucceſs I had in a trial or two made in another glaſs, and once, with ſucceſs, about nine a clock at night. In moſt of theſe experiments I forbore to ſhake the glaſs, leſt that ſhou'd be ſuſpected to raiſe ſome fine powder that might be precipitated out of the tincture, tho' I never perceived any ſuch. But if by the agitation of the liquor more parts of it were expoſed to the action of the air, the colouration would be haſtened.

Experiment 3. Having covered the bottom of a conical glaſs with filings of good copper, we poured ſtrong ſpirit of Sal armoniac upon them, till it roſe about a finger's breadth above them; and having let down a mercurial gage, ſo that it reſted againſt the bottom and ſide of the glaſs, we cloſed it very well with the ſtopple, and ſet it in a quiet well enlightened place, obſerving where the quickſilver reſted in the gage. The menſtruum work'd ſlowly on the filings, without producing any noiſe or ſenſible bubbles; gradually acquiring a very pleaſant blue colour. We perceived alſo from time to time, that for two or three days together, the mercury in the ſealed leg of the gage very ſlowly deſcended, till it appeared near a quarter of an inch lower than at firſt. The event of the experiment ſeemed ſufficiently to argue, that the ſpring of the air, contain'd in the cavity of the glaſs, communicating with that in the open leg of the gage, was weakened in compariſon of that of the cloſed leg; which by the hermatic ſeal on one ſide, and the quickſilver on the other, was kept from ſuch communication. I further obſerved, that the depreſſure continued at different times of the day; tho' at noon the ſun ſhone hot upon the place and veſſels. This experiment was made four or five times, but not always with equal, yet with ſome ſucceſs; the mercury in the ſealed leg of the gage being ſometimes more and ſometimes leſs, but always manifeſtly depreſſed; which phenomenon was confirmed by the obſervation we more than once made of the ſudden return of the mercury to its former ſtation, upon unſtopping the glaſs, to give free admiſſion to the external air.

Experiment 4. A mercurial gage being put into a conical glaſs, the bottom whereof was covered with beaten coral, we poured thereon ſome ſpirit of vinegar, and cloſing the neck exactly, obſerved many bubbles were for a long time produced, which ſucceſſively broke into the cavity of the veſſel, whereby they compreſſed the air in the cloſe leg of the gage into about a third part of its former dimenſions. But ſome hours after the corroſion had ceaſed, the compreſſion made by this new air grew manifeſtly fainter, and the air impriſon'd in the gage drove down the mercury again to within about one diviſion of its firſt ſtation; where it continued for five or ſix days. So that there here ſeems to have been a double compreſſive power exerciſed; the one tranſient, by the briſk agitation of the vapours or exhalations, and the other durable, from the aerial and elaſtic particles, either produced or extricated by the action of the ſpirit upon the coral.

Experiment 5. A conſiderable quantity of ſpirit of vinegar being put upon minium in a conical glaſs, furniſhed with a glaſs ſtopple and a mercurial gage, no ſenſible depreſſure of the mercury appeared in either leg for ſeveral days; nor did any change happen in the gage upon removing the ſtopple, tho' it was evident by the great ſweetneſs acquired, that a large proportion of the minium was diſſolved.

Experiment 6. Into a round eight ounce vial we put ſome copper filings and a mercurial gage, pouring ſtrong ſpirit of Sal armoniac on the metal, till it reach'd to a conſiderable height in the vial, which being hermetically ſealed, was ſet in a ſouth window, where the liquor ſoon acquired a deep blue tincture, which in twelve days time grew gradually pale, till at length it appeared like water. During this, the mercury in the open leg ſeem'd to be impell'd up, and at about nine a clock at night we broke off the hermetic ſeal, upon which a noiſe was immediately produced, and the mercury in the ſhorter cloſed leg briskly impell'd to the height of near $\frac{3}{4}$ inch, and tho' the orifice whereat the air entered, would ſcarce admit a middle ſized pea, yet within a minute and half the ſurface of the liquor appeared to have acquired a lovely fair colour, reaching downwards $\frac{1}{4}$ inch; ſo that the vial ſeemed to contain two very different liquors, ſwimming upon each other; and the colouration becoming gradually deeper, the whole within five minutes obtain'd a rich blue colour.

Generation and destruction of air.

That air is greatly concern'd in producing many phenomena of nature, either altogether new, or not formerly aſcribed to it, has been of late ſufficiently ſhewn. And that it is alſo neceſſary to the exiſtence and motion of moſt animals, may be eaſily deduced from my experiments made with the air-pump, relating to reſpiration. This fluid being of ſo great importance, made me ſollicitous to enquire, whether it was producible by art; for if ſo, it might help to explain ſome difficult phenomena; and be otherwiſe very ſerviceable in human life, as particularly in the art of diving, and ſubmarine navigation.

By the production of air, I here mean the obtaining a ſenſible quantity of that fluid from bodies wherein it did not before appear, either at all, or in ſo great plenty; tho' perhaps ſome of our experiments may argue a new and real production of air, in the ſtricter ſenſe of the word.

This enquiry will conſiſt of two parts; the methods of producing what appears to be air; and thoſe of examining how far the ſubſtance produced has the real properties of air.

I muſt here obſerve, that many accidental qualities are aſcribed to air; but having found what beſt diſtinguiſhes it from aqueous vapours, earthy exhalations, and the effluvia of other bodies, to be, as was ſaid, a durable elaſticity; I ſhall here make uſe of that as the principal critereon, to try whether any portion of matter be aerial.

Among the ſeveral ways of producing air, the fitteſt for practice ſeem to be fermentation, corroſion, and the diſſolution of bodies, by the boiling of water and other liquors, by the mutual actions of bodies upon one another, eſpecially ſaline ones, and laſtly, by analyſing and reſolving certain ſubſtances.

Experiment I.

Into a long and large tube we conveyed filings of ſteel, a proper quantity of water, a ſealed glaſs of oil of vitriol, with a hole near one end, and a mercurial gage; when having exhauſted the air from them all, till the mercury in the gage was almoſt wholly impelled into its open leg, we exactly cloſed up the external veſſel: Then gradually, and at long intervals, pouring the included oil of vitriol upon the ſteel and water, exceeding large bubbles were thereby produced, with a ſmall, ſenſible heat. During the conflict much air ſeem'd to be generated by theſe bubbles, ſo that, at length, the mercury in the gage, being impelled to the very bottom of the open leg, the air included in the other appear'd more compreſs'd than by the weight of the

AT.HIST. the atmoſphere, before 'twas thus employ'd. We removed the whole into a cooler room, where I found, the next day, no ſenſible alteration in the gage; and thus it continued for three or four days; but coming afterwards to look upon it, the mercury had aſcended about an inch and a half; and near the ſame quantity of water had got into the ſealed leg of the gage. But this was, very probably, owing to a careleſs removal of the tube that had been made, without my knowledge; for I have found no other remarkable alteration herein ſince the experiment was firſt undertaken, which is now eight or nine days; the mercury in the open leg ſtill remaining at about the height of an inch and half.

eriment 2. I filled a pint vial with wheat-flower well drenched in water, ſtopping up the orifice both with cork and cement, and ſet it in a warm place of the laboratory, in a cold ſeaſon; where it continued for thirteen days, when it burns by the dilation of the included matter, which was, the night before, obſerved to have left a conſiderable vacancy below the cork. The matter to me taſted ſouriſh, but to another acid.

eriment 3. We ſet a convenient quantity of bruiſed raiſins to ferment with water, in a bolt-head, including alſo a mercurial gage therein; when exhauſting the air, and preventing any from returning into the veſſel, 'twas placed in the warm laboratory. No ſpringy ſubſtance appear'd to be hence generated in four days, tho' the liquor, it ſeems, afterwards fermented more violently than the cold ſeaſon might be thought to allow of; for being not carefully looked to, the middle part of the glaſs broke to immenſly ſmall pieces, with a report equal to that of a piſtol; whilſt the bottom and neck remain'd tolerably entire.

eriment 4. I fill'd a wide-mouth'd three pint glaſs, with a proper quantity of water and bruiſed raiſins. Upon the mouth of the glaſs we tied a large bladder by the neck, but firſt carefully freed from air, and faſten'd it well thereto with cement, to prevent any air from paſſing either in or out. In this condition we left the glaſs in the laboratory for fourteen days, when finding the bladder tumid, we ſhould have tied up the contain'd air therein, but for a ſmall hole there chanced to be in it. We therefore took it off, and cauſed a very limber one, capable of holding a quart of water, to be fix'd on in the ſame manner, and found it next morning ſo full of air, that we could not, without difficulty, and the loſs of a conſiderable quantity, tie up the bladder near its neck. Another bladder was afterwards applied as the former, which next morning appear'd full, as if diſtended by means of a pair of bellows.

eriment 5. In the bottom of a wide-mouth'd vial we lodged ſome good ſpirit of ſalt, and the filings of ſteel, covering all with a receiver, fitted with an eel-skin, and a wire, whereto a thin and ſlender glaſs, hermetically ſeal'd at the bottom, was fixed, containing ſome filings of copper. The receiver being well exhauſted, we broke this glaſs of copper filings againſt the bottom of the vial, and let them fall into the menſtruum, whence enſued great ſtore of bubbles, which raiſed a froth much deeper than the liquor; and the ſucceſſive generation hereof continued for a conſiderable time; ſome of them appearing large, tho' in the open they would, perhaps, have been inviſible. The vial thus kept *in vacuo* for a quarter of an hour longer, and no greenneſs appearing in the liquor, the receiver was taken off.

Experiment 6.

A bubble of air, equal in diameter to a middle ſized pea, being left at the top of a round vial, with a long and ſlender neck, and containing fine oil of turpentine, this was inverted into another vial of the ſame liquor, and ſuffer'd to ſtand in a quiet place for a competent time. The like was alſo done with ſpirit of wine at the ſame time. The event was, that in ſix days the bubble diſappear'd in the glaſs of oil of turpentine, and likewiſe in that of the ſpirit of wine the day following.

Experiment 7.

Upon opening an exhauſted receiver, wherein was an unſtop'd vial above half full of an opake blackiſh liquor, ſuppoſed to have been frogs ſpawn, that had certainly been included for three years, we found by the gage put up with it, that it had yielded a little air. Its ſcent was fetid, like that of the pump of a ſhip, but it had produced no inſects, nor was turn'd mouldy.

Obſervation.

An induſtrious gentleman of my acquaintance, who digs for mines, and owns a good one, informs me; that when the miners meet with running water under ground, they are thereby ſupplied with air ſufficient for free reſpiration, even at the depth of many fathoms; but ſtagnant water, he ſaid, would not do the like. Tho' in his opinion, that air proceeded rather from the water it ſelf, than from its motion.

Experiments about the production of air, and the examination of it, propoſed.

1. To produce air by fermentation in well cloſed receivers.
   To produce air by fermentation in ſeal'd glaſſes.
   To ſeparate air from liquors by boiling.
   To ſeparate air from liquors by the air-pump.
   To produce air by corroſion, eſpecially with ſpirit of vinegar.
   To ſeparate air by animal and ſulphureous diſſolvents.
   To obtain air in an exhauſted receiver by burning glaſſes, and red-hot irons.
   To produce air out of gunpowder, and other nitrous bodies.
2. To examine the produced aerial ſubſtances, by their preſerving or reviving animals, flame, fire, the light of rotten wood, and of fiſh.
   To examine it by its elaſticity, and the duration thereof.
   To do the ſame by its weight, and its elevating the fumes of liquors.

The drineſs and moiſture of the air.

I am not ſollicitous that all the phenomena refer'd to the moiſture of the air, be ſolely produced by the bare moiſture thereof, 'tis ſufficient if this quality is the moſt obvious one, tho' other corpuſcles whereto moiſture ſerves as a vehicle, be alſo concern'd herein.

Dryneſs, as privative as its nature ſeems, may have a conſiderable ſhare in producing a change in bodies, and that in differing reſpects; the two principal whereof are theſe.

First, by means hereof a body is deprived of thoſe exhalable parts that harbour'd in its pores, and were perhaps the principal of ſeveral operations aſcribed to it. Secondly, as the want of theſe more ſubtile parts may induce a change of texture in the body, chiefly with regard to its pores, whoſe magnitude, figure and poſition being alter'd, the body may in many caſes acquire a contrary diſpoſition to its own.

ſervation. Sometimes when the weather began to be overcaſt, the hygroſcope did not grow ſenſibly heavier, and at other times it wou'd, when I cou'd obſerve no vapours in the air. Indeed it happened thus but ſeldom, yet this made me ſuſpect that ſome clouds may conſiſt of other than aqueous exhalations; and that ſuch as are peculiarly fitted to enter the pores of the hygroſcope, have a faculty of drying it, or ſome way or other of increaſing or leſſening its gravity. And this ſeems the more probable, becauſe having made hygroſcopes with powder, with ſalt, and with wainſcot ſaw duſt, applied to nice ſcales in very thin light open glaſſes, they all ſucceeded as the former; for now and then their weight would not alter as the weather grew moiſter or dryer.

xperiment 1. Soon after looking upon the half hundred weight that hung by a rope, and fixing a mark where the bottom of it touch'd the perpendicular board that ſtood by it, I perceived the sky, which before was clear, to grow cloudy, but no rain enſued; upon this the weight roſe a quarter of an inch within an hour and a quarter after the mark was made, as it proved, between nine and ten in the evening. Between eight and nine the following morning, it was raiſed near an inch from the former mark, when the day proving fair and windy, the weight ſunk by ten at night about ſix inches below where I found it in the morning. The morning following, about eight a clock it was riſen to 8 $\frac{1}{4}$ inches, the weather being then cloudy, tho' very dry and duſty; but in leſs than an hour after it overcaſt, and there fell ſome drops of rain, which made the lead to riſe about half an inch higher.

The night proving rainy, the half hundred weight was lifted above five inches higher than I left it the preceding evening, but the day recovering to dry, windy, and warm, it was ſunk by the next night conſiderably below all the marks. The rope whereby this weight was ſuſpended, meaſured in diameter three eighteenths and four decimal parts of the tenth of an inch.

[illegible]ment 2. A rope about three feet and a half in length from the point of ſuſpenſion, and near three tenths of an inch in diameter, being ſtretched for ſome days by a leaden weight or quarter of the large hundred, which had a flat board placed underneath, juſt barely to ſupport it; we at length moiſtened the rope thoroughly with water, by means of a ſpunge, whereby it firſt ſeemed to be rather a little lengthen'd than ſhorten'd; but in an hour or two it began to contract, ſo that the weight was raiſed conſiderably above the board whereon it reſted before; on the ſame day, however, the weight ſunk to its former place.

Tho',

Obſervations.

Tho' *Morocco* be an inland town, ſeated in a very hot climate, where the ſoil is uſually dry; yet I am inform'd that the nocturnal air proves exceeding damp and piercing, ſo as preſently to produce ruſt upon ſuch iron inſtruments as lie naked therein.

Air too moiſt cannot be wholeſom. The air about *Oakly* in *Buckinghamſhire*, tho' a high country, is very moiſt between *Michaelmas* and *Alhallontide*, eſpecially in rainy weather, and upon a thaw; ſo that the wainſcots, ſtair-caſes, and pictures, then ſtand of a water, which will afterward trickle down in large drops. But many houſes at *Brill*, which ſtand exceeding high, have this to a much greater degree; for here the ſtair-caſes, eſpecially if laid in oil, will run down with water. The north and north-eaſt ſides of theſe houſes are obſerved to be the dampeſt; for the furniture here will rot, if fires be not ſometimes made in the rooms wherein it ſtands.

Experiment 3.

As by exhauſting a receiver of air, we formerly tried whether the remaining medium wou'd thereby alter its temperature, as to heat and cold, ſo in the preſent experiment we endeavoured to find its diſpoſition with regard to dryneſs and moiſture. The hygroſcope made with the beard of a wild oat, ſeem'd very proper for this purpoſe; but that not being procurable, we uſed one of gut-ſtring. This was convey'd into a ſmall receiver, that the effect might be the more ſudden and conſpicuous; yet no ſenſible alteration appear'd in the index upon extracting the air. And tho' we repeated the experiment, and then kept the receiver for a conſiderable time exhauſted, the conſequence was the ſame; but upon the re-admiſſion of the air by the cock only, the index in a few hours conſiderably changed its place; ſo that hence the ſubtile matter in the ſuppoſed vacuum of the receiver, and conſequently the more fluid part of the atmoſphere, wherein the proper aerial particles float, appears not, in its own nature, to be very ſenſible either of cold or heat, dryneſs or moiſture; tho' many other experiments remain to be tried, beſides thoſe wherein the air-pump, thermometer, and hygroſcope are concern'd, before this can abſolutely be determin'd.

Clouds & miſts.

An excellent aſtronomer of my acquaintance, who frequently took the height of the clouds, very rarely found any even of the white ones, in fair weather, to be more than three quarters of a mile, and ſeldom above half a mile, from the ſurface of the earth.

A miſt driving upon the ſea towards the ſhoar, tho' without any ſenſible wind, will cauſe a greater ſwell of water than a briſk gale.

A moiſt bluiſh miſt has been obſerved to aſcend from ground that is ſomewhat moiſt in winter, and elſewhere after a warm day, or againſt fair weather in autumn, to the height of twenty or thirty feet, and then to ſubſide again in dew.

Terreſtrial ſteams in the air.

A virtuoſo of my acquaintance, who poſſeſſed a piece of ground wherein ran ſeveral veins of different metals and minerals, as alſo his ſon, a virtuoſo, told me, they had frequently ſeen pillars, as it were of fumes, aſcending thence like ſmoke, ſome whereof had no ſcent, ſome an ill one, and ſome again a good one, tho' the latter happen'd but ſeldom. And I my ſelf have known diffuſive and laſting fogs that have proved very fetid.

Smoky ſteams frequently proceed from the air-ſhafts of mines whilſt they lye unwrought; and the charcoal made of the wood that grows near the mineral mines in *Cornwal*, affords a manifeſt, arſenical, and ſulphureous ſcent.

" A terrible exhalation aroſe from the *Cretan* ſea, at the beginning
" of the ſummer of the year 721, which diffuſing it ſelf in the air,
" cauſed it to appear all on fire. The ſea it ſelf was alſo, by huge
" flaming ſtones that ſtarted from the iſle called *Hiera*, heated to a
" violent degree." *Journal de Savans.* 1685.

The atmo- here a very mpounded dy.

The ſchools teach the air to be a warm and moiſt element, and conſequently a ſimple and homogeneous body. Many modern philoſophers have, indeed, juſtly given up this elementary purity in the air; yet few ſeem to think it a body ſo greatly compounded as it really appears to be. The atmoſphere, they allow, is not abſolutely pure, but with them it differs from true and ſimple air, only as turbid water does from clear. Our atmoſphere, in my opinion, conſiſts not wholly of purer æther, or ſubtile matter, which is diffuſed thro' the univerſe, but in great meaſure of numberleſs exhalations of the terraqueous globe; and the various materials that go to compoſe it, with perhaps ſome ſubſtantial emanations from the celeſtial bodies, make up together, not a bare indeterminate feculency, but a confuſed aggregate of different effluvia. One principal ſort of theſe effluvia in the atmoſphere I take to be ſaline, which float variouſly among the reſt in that vaſt ocean; for they ſeem not to be equally mixed therein, but are to be found of different kinds, in different quantities and places, at different ſeaſons.

Salts in the r.

The arguments that ſhew ſubterraneous effluvia, in general, aſcend plentifully into the air, prove the ſame of ſaline ones in particular; ſince it has been demonſtrated, that immenſe quantities of common, nitrous, aluminous, vitriolic, and perhaps other ſalts, riſe among the various exhalations of the terraqueous globe. Nor is this the only means whereby the air may be impregnated with ſaline particles; for the action of the ſun upon the ſuperficial parts of the earth and ſea, will, alone, ſupply that fluid with ſwarms of them. And the quantity hereof may be greatly increaſed in ſeveral places by ſuch vulcano's as have open vents, by the ſmoke of the common culinary fires, *&c.*

We might here enquire, whether the ſalts of the air be really of different kinds; and if ſo, what thoſe kinds are; and how it comes by them?

Many learned men talk much of a volatile nitre in the air, as the only ſalt wherewith that fluid is impregnated. I muſt own the air, in many places, ſeems to abound in corpuſcles of a nitrous nature; but I don't find it proved by experiments to poſſeſs a volatile nitre. In all my practices upon ſalt-peter, I found it difficult to raiſe that ſalt by a gentle heat,
and

and ſpirit of nitre, which is drawn by means of a vehement one, has quite different properties from crude nitre, or the ſuppoſed volatile kind in the air; for 'tis exceeding corroſive. And even the earth dug from under an old dove-houſe, and diſtill'd with ſlow fires, yielded nothing like that wherewith theſe men ſuppoſe the air to be ſtored. I am content, however, to admit their ſuppoſition as ingenious, till farther evidence be given for it; and this ſeems not impoſſible to be produced, at leaſt as to particular times and places. For I would not be poſitive, that the ſubterraneous exhalations, or the rays of the ſun, never volatilize any of the nitrous particles they act upon, and elevate them into the air, without deſtroying their texture like our fires. But this will not appear to be the only ſalt that impregnates the air, if we conſider how vaſt a portion of the terraqueous globe is cover'd with the ſalt ocean, and what immenſe quantities of foſſil ſalt are dug up in *Poland*, *Hungary*, *Tranſylvania*, &c. that ſea ſalt is generally found mixed with nitre in the earth, and that it is with difficulty ſeparated therefrom. For hence it ſhould ſeem, that in many places, eſpecially near the ſea, the effluvia of common ſalt abound in the air equally, at leaſt, with thoſe of nitre.

In places abounding with marcaſites, there is a fretting vitriolic ſalt largely diſperſed thro' the air, which has been obſerved to rot the hangings of rooms, and other furniture; and to lie upon the ſurface of the ground in a whitiſh efflorеſcence, after the ſun had heated the moiſt and blackiſh mould wherein it lay.

But farther, the air of particular places, as about great towns, *&c.* may likewiſe, probably, abound with volatile ſalts, of a contrary nature to acids. That places deep under ground may lodge ſuch ſalts, ſeems not unlikely from the experiment of an acquaintance of mine, who cauſed to be dug up, at the depth of ſeveral yards below the ſurface of the earth, a large quantity of a certain kind of clay, abounding in minerals; whence he obtain'd, by ſimple diſtillation, a conſiderable parcel of ſpirit and ſalt, greatly reſembling thoſe of urine or hartſhorn.

In places where much wood is burnt, numerous particles of volatile ſalt may eaſily be diſperſed thro' the adjacent air; for wood-ſoot, which is only that ſmall part of the ſmoke which adheres to the chimney ſides, affords a volatile, ſaline ſpirit in great plenty; and not readily, unleſs by the ſcent, diſtinguiſhable from that of urine or hartshorn.

Moreover, the putrefaction of animal ſubſtances may ſupply the air with volatile ſalts, ſince ſome putrefied urine will, without diſtillation, afford ſaline and ſpirituous parts, which by their ſcent, *&c.* diſcover themſelves to be volatile, even while ſwimming in their own large quantity of phlegm. The like, I believe, is obſervable in many vegetables; for ſome ſucculent ones being laid together in a heap, at a convenient ſeaſon of the year, that they might rot, I found them, when the putrefaction had arrived to a certain degree, to yield a ſurprizingly fetid ſcent, like that of carrion; and that a vegetable will of it ſelf afford a dry volatile ſalt, I know by experience, having my ſelf obtain'd it from a ſpirituous ſeed, tho' I muſt confeſs, not without previous incineration; and only from two or three ſuch ſubſtances.

But the air of ſome places may, beſides thoſe ſimple ones already mention'd, contain ſome compound ſalts, ſince I have ſhewn, that particular ſaline ſpirits may meet and join together therein; as alſo that two liquors may be ſo order'd, that tho' one of them ſhall never, of it ſelf, afford any thing in a dry form; yet its ſpirituous effluvia meeting with thoſe of the æther, will produce a dry, volatile and ſaline body; which a mixture of the liquors themſelves would not.

The many ſaline effluvia that riſe with the other ſubterraneous ſteams, cannot, all of them, be well ſuppoſed of a ſimple and uncompounded nature. A very intelligent acquaintance of mine, who viſited a vulcano in *America*, told me, that before he came near enough to the fire, to be very ſenſible of its heat, the skin of his face was ſo corroded, and the colour of his hair ſo changed by the exhalations, as to prevent his nearer approach thereto.

'Tis well known that about mount *Veſuvius*, the exhalations are of ſo ſaline and ſulphureous a nature, that they adhere to the orifices of its vents, like the flowers of ſulphur. And I have had ſtone brought me from ſome vulcano, with a white ſalt in its cavities; which, upon examination, proved a-kin to ſal armoniac, and eaſily ſoluble in water; one part being very volatile, and the other remaining ſomewhat fixt; whence it ſeems very probable, the ſalt was compounded in the bowels of the vulcano; great quantities thereof having, as I am credibly inform'd, been caſt up in the fiery eruptions; and therefore, ſince I found it ſublimable, it might, by that means, be largely diſperſed thro' the air.

Beſides theſe ſaline ſubſtances of a determinate ſpecies, there are poſſibly, at certain times and places, other corpuſcles in the air of a ſaline nature, but not reducible to any particular kind, which I therefore call anonymous. We have obſerved in old glaſs windows, belonging to high and ancient buildings, ſome panes corroded, as if they had been worm-eaten; which ſeems to argue, that ſharp and fretting particles had been carried thither by the winds whereto that glaſs was expoſed. But none of the ſalts beforementioned have the faculty of corroding common glaſs. Other inſtances might be produced upon this occaſion, but I reſerve them for another treatiſe.

To diſcover the ſalts in the air.

The general method of diſcovering the ſalts in the air, may conſiſt of ſeveral particulars. Thus, in the firſt place, it might be proper to lay open to the air, ſuch bodies as have a diſpoſition to be affected by the ſalt, wherewith 'tis moſt likely to abound. For inſtance, if we ſuſpect the air to be impregnated with nitre, lime, or the like bodies, that imbibe or retain ſuch a ſaltneſs; died cloths or ſilks of ſuch particular colours as will fade or tarniſh with nitrous ſpirits, may be expoſed thereto. Where vitriolic effluvia are ſuppoſed predominant, proper preparations of ſulphur ſhou'd be ſuſpended, to try whether they will acquire a blackneſs. In other places, gueſſes might be made, by ſpreading on the clean ground, white linen cloth, well freed from ſope or ly; and obſerving, after it has lain a conſiderable time, what diſcolouration it has ſuffer'd, and what ſaltneſs it has imbibed; either from the aſcending ſteams, or falling dews. Another way is, to find ſome particular body capable of being affected by ſeveral aerial ſalts, in ſuch different manners, as to diſcover which kind produced the reſpective changes. 'Tis doubtleſs difficult to obtain ſuch a body, yet perhaps the thing is not impoſſible.

Experiment 1.

Having cauſed ſome thin copper plates to be made clean, I kept them over glaſſes, filled with different ſpirits, as of common ſalt, and of nitre, both pure and diluted with water; whereupon I obſerved, tho' no heat was applied to the glaſſes, yet fretting particles aſcended from the liquors in leſs than a day's time, when the ſpirits, juſt mentioned, had greatly darkened the under ſurface of the plates, by different diſcolourations; ſo that 'twas afterwards eaſie to ſee which was cauſed by the ſaline, and which by the nitrous effluvia.

Spirit of nitre, as I formerly found, makes, with copper, a greeniſh blue ſolution; ſpirit of ſalt, a graſs green liquor; and the ſpirit of ſoot and urine, a deep blue, almoſt like ultramarine. But want of time hindered me from proſecuting theſe experiments; which might poſſibly have had a happy iſſue. And what farther keeps the thing from appearing deſperate, is, that I have ſeen pieces of malleable copper, from an engliſh mine, overcaſt here and there with a fair verdigreaſe, which appeared, by circumſtances, to have proceeded from the corroſive effluvia of the air. Perhaps, alſo, there are other ſubterraneous or metalline bodies, that by the colour, peculiar ruſt, or ſtain they acquire in the air, may enable us to conjecture with what ſubſtances or ſalts the air of the place is impregnated. I knew a ſtately houſe which received this peculiar inconvenience from the effluvia of the air wherein 'twas ſeated, that the ſilver plate could not, by any means, be preſerved from odd diſcolourations, tho' carefully kept in a convenient part of it. And in *Amſterdam*, I am told, plate tarniſhes immediately, upon being expoſed to the air; and contracts a dirty colour, betwixt a yellow and a black. A third way is, by the uſe of metalline bodies, chymically prepared, and previouſly reduced to fine parts, by means of ſaline ſubſtances. Here ſuch bodies, or factitious minerals, are to be employed, as having, generally, an accidental colour, will change it in the air.

Experiment 2.

A ſtrong ſolution of pure ſilver in *Aqua fortis*, precipitated with ſpirit of ſea-ſalt, gives a white powder, which being expoſed, for a conſiderable time, to the air, will acquire a dark colour on its ſurface, wherein an attentive eye may, perhaps, diſcern variations, as any particular ſaltneſs happens to predominate in the air.

We

Experiment 3. We mixed an equal weight of copper filings and powdered ſal-ammoniac together, and put them into a covered crucible, which was kept over a moderate fire, till the ſalt had done fuming; when all the remaining dark coloured maſs that could be ſeparated, being taken out, groſly bruiſed and expoſed, for ſome time, to the air, it looked like a kind of verdigreaſe, a ſubſtance whoſe colour may be obſerved to vary according to the nature of the particular ſalts, which by corroding and incorporating with the copper, produce the pigment. But a parcel of the ſame maſs being groſly powder'd, before the air could much affect it, and hermetically ſealed up in a glaſs egg, and left in a ſouth window, it did not appear diſcoloured, when the external ſurface of the other parcel reſembled verdigreaſe; which argues the change of colour to have been made by the aerial ſalt, if the moiſture of the air had no ſhare therein, but as a kind of vehicle to the ſalt.

Experiment 4. By pouring ſome ſpirit of wood-ſoot on filings of copper, I obtain'd a deep azure colour'd ſolution like ultramarine, which being ſuffered to dry in an open glaſs by the ſole operation of the air, the colour preſently became paler, reſembling that of a good turquoiſe. The ſame ſucceſs I, likewiſe, had with an urinous ſpirit, drawn from animal ſubſtances and copper filings.

To deſcribe the above-mentioned changes more particularly, would have been ſo exceeding difficult, that I did not attempt it; for few, beſides painters, can diſtinguiſh all the uſual variety of colours by proper names. And beſides, perhaps there are ſome that no language can expreſs, eſpecially when they have been attentively viewed and conſidered; tho' by a knowledge herein it might ſometimes be aſcertained what ſubſtances in the air are denoted by ſuch variations.

It does not appear that our inland countries abound conſiderably with corroſive ſalts, ſince the bars and caſements of windows will not thereby be greatly impaired by ruſt, after they have endured the weather for twenty years; whence I conjecture, that kind of ſalt proceeds from the ſea vapours, or thoſe raiſed by the burning of mineral coals.

" The pot being taken from the fire, and ſuffered to cool, is
" emptied of its pure nitre, that reſemble white marble; the terreſtrial
" part remaining at the bottom. The earth wherewith the ſolution was
" made, and the boughs of oak, or the like trees, are then to be alter-
" nately expoſed to the air, and ſprinkled with water, wherein nitre
" has been diſſolved; and by this means, in five or ſix years time, it
" will be again fit for ſolution. The purer parts of the nitre thus
" generated, as alſo that which hangs upon the walls in wine vaults,
" is to be mixed and boiled with the firſt ſolution. But if any place
" yield many of theſe veins, they ſhould not immediately be laid up
" in the reſervatories, but be firſt thrown on a heap in open ſpaces;
" for the longer they lie expoſed to the air and rain, the better

“ they grow; and in four or five months after this, fibres will ſhoot “ out, which are much more excellent than the veins. If a ſeparation “ tion do not happen in the ſecond boiling of the decoction, pour it “ out of the ſmaller veſſels into the larger, and let it be ſhut up “ therein, when alſo the copperas will ſeparate from the alum, and “ run into lumps; but that which will not concrete in the veſſels, “ ſhould be boiled again, and the earth that ſtays behind thrown “ back into the reſervatory, together with the veins, to be there afreſh “ diluted with water and urine. The earth remaining in the reſer- “ vatories after ſolution, becomes gradually more aluminous and “ juicy, as that whence nitre was made.” *Agricola de re metallicâ.*

A learned phyſician, who practiſed in the moſt ſouthern parts of the *Engliſh* colonies, told me, that the great guns there are ſo ſubject to ruſt, that after lying a few years in the open air, large cakes of *Crocus martis* may, with a hammer, be eaſily beat off them; whilſt others that lay ſunk in ſalt-water, during the ſame time, were by no means ſo much affected. And as dew is only ſteams of the terreſtrial globe, the phenomena that manifeſt its power to work on ſolid bodies, may help to ſhew how much the air abounds with ſaline and ſubtile parts. The dew about the maritime places of *Braſil*, and even part of the inland country, a ſcholar, who had been there, aſſured me, not only gave a ruſt to knives, and ſuch like inſtruments, but alſo to coin. He added, that the *Portugueze* are there obliged to caſe their great guns, to prevent their being corroded by it, ſo as to break in diſcharging; and that he often obſerved it left a pure, white ſalt, like a hoar-froſt, on the graſs and trees. Another ingenious phyſician informed me, that at *Fahlun* in *Sweden*, noted for one of the beſt copper mines of that kingdom, the mineral exhalations affect the air ſo, that their ſilver coin is frequently diſcoloured, and ſometimes turned black thereby; tho' cloſe tied up in ſeveral purſes, and lock'd up in ſtrong cheſts. He ſaid alſo, that theſe effluvia manifeſtly affected braſs, and to that degree too, as to occaſion ſeven crowns of that metal, reſerved in one of their principal churches, to remain unclean'd, and perfectly black; becauſe they foul'd ſo faſt, as render'd the trouble of keeping them bright almoſt endleſs. Theſe corroſive exhalations, he farther aver'd, penetrate the bars and veſſels of iron, that lie expoſed to the air, ſo freely, that friable ſcales of ruſt may, at no long intervals, be eaſily obtain'd therefrom.

Sulphur in the air. A *Neopolitan* nobleman acquainted me, that during his ſtay at a country-houſe near *Naples*, he uſed frequently to ride upon a very ſulphureous ſoil, where, if his horſe trod pretty hard, a great crackling noiſe would ariſe; which, to a ſtranger, might have ſeem'd ſurprizing, and duſty ſulphureous fumes be raiſed, which ſeem'd ready to take fire, as ſometimes he thought they actually did; and having cauſed ſome turfs to be cut out of this ground, and laid together in a heap, he could, in the night time, ſometimes obſerve the effluvia thence plentifully ariſing to kindle in the air. The ſame honourable perſon likewiſe aſſured me, that in the late eruptions of mount *Veſuvius*, both he and others were greatly amazed at the prodigious height of the flame which ſhot up from that *Vulcano*; and that by means of a quadrant, they found it reach'd two miles above the top of the mountain. He added, that the adjacent earth would ſometimes tremble, that vaſt ſtones and heavy bodies would be diſcharged, and that he himſelf had there ſeen fiery maſſes of matter thrown into the air, each of them capable of filling a large room.

“ The iſland has a ſhocking appearance; the proſpect from the port is the ſea, and ſhore all black and burnt, by a ſmall rock that firſt diſcovered it ſelf about ſixty years ago, vomiting out a prodigious flame at a cavern of an immenſe depth. 'Tis not above eighteen years ſince, on a ſunday night, that a terrible noiſe began at the port of *Santorini*, reaching even to *Chio*, diſtant therefrom above two hundred miles, which was ſuppos'd to proceed from the *Venetians* fighting with the *Turks*; but at length it was found to be cauſed by a fire underneath the port above-mentioned, which there caſt up, from the bottom of the ſea, quantities of pumice-ſtones, with a force and report as great as if they had been ſeverally diſcharged from a canon. The air of *Santorini* was by this means ſo infected, that abundance of people were kill'd, and many loſt their ſight thereby, tho' they recover'd it in a few days afterwards. This infection ſpread it ſelf as far as the preceding noiſe had reached; for even at *Chio* and *Smyrna* all the ſilver coin was changed red, both that in the pocket, and that lock'd up in cheſts; and the ſame happen'd to the ſilver chalices in the churches. The infection, however, vaniſhed in a few days time, and the ſilver recover'd its native colour; but the pumice-ſtones that were thrown up, cover'd the *Archipelago* to ſuch a degree, that for a conſiderable time, when particular winds blew, the port was block'd up with them; ſo that not the leaſt veſſel could paſs, till way was made for it by their removal. And ſome ſcatter'd remains of them may be ſeen to this day in the *Mediterranean*. *Seneca* tells us, that *Santorini* is built upon mines of ſulphur, which doubtleſs gave occaſion to this fire.” *Voyage de Levant.*

'Tis a common obſervation, that thunder produces in the air a ſtrong ſmell of ſulphur; and I remember being at a town near the lake of *Geneva*, when the thunder was ſo violent, as greatly to terrify the inhabitants, tho' they were accuſtom'd to its ſhocks; I heard many complaints the next day of a ſtrong ſulphureous ſcent, that particularly proved almoſt inſufferable to the centinel who ſtood near the lake where the thunder fell.

“ On *July* 24. 1681. The ſhip *Albermarl*, diſtant an hundred leagues from *Cape Cod*, in the latitude of 48°, about 3 in the afternoon, meeting with a thunder ſtorm, the lightning burnt the main-top ſail, ſplit the main cap in pieces, and ſhiver'd the maſt. One of the claps of thunder

" here proved exceſſively loud, whereat the whole ſhip's crew were " aſtoniſhed; when ſomething immediately fell from the clouds upon " the ſtern of the ſhip-boat, which broke it into ſeveral pieces, ſplit " one of the pumps, and damaged the other. It ſeem'd to be a bituminous matter that caus'd this miſchief, ſmelling like fired gunpowder, and continuing to burn in the ſtern of the boat till it was " wholly conſum'd; for they cou'd not extinguiſh it by water, and " attempting to diſſipate it with ſticks. But, what is more extraordinary, " when night came on, and the ſtars appear'd, they found their compaſſes changed. That in the biddekel had its north point turned " due ſouth: one of the two others, which lay unhung in the locker " in the cabbin, pointed exactly as the former; but the north point " of the third ſtood weſt. The polarity of their needles being thus " changed, the ſailors were for ſome time at a ſtand how to work " their veſſel; however, they afterwards ſailed a thouſand leagues " in this manner. That compaſs whoſe needle thus came to point " weſt, was brought to *New-England*, where the glaſs being broke, and " the air gaining entrance, it loſt its virtue. But one of the others " is in that country poſſeſs'd by Mr. *Encreaſe Mather*; the north point " of the needle remaining ſouth to this day."

An eminent planter of trees, gave me part of a branch, with a fiſſure in the bark, that ſeem'd almoſt to reach the wood, from one end to the other; tho' the lips of the wound were now grown over with new bark. The like hereto he obſerved in other branches of the ſame tree; and this, for ſeveral reaſons, he could aſcribe to nothing but lightning, which about that time had been very frequent; and many more trees, as well his own as thoſe of others, far diſtant from the former, were affected in the ſame manner. Theſe fiſſures looked not all one way, but reſpected ſeveral points of the compaſs; whence I am confirm'd in my ſolution of ſome odd phenomena of lightning, by comparing its irregular, winding motion, to that of a ſquib. However this ſtrange kind of fire may affect animals, 'tis not always pernicious to vegetables; as appears from the juſt mention'd wounds it makes in trees, which happily cicatrize of themſelves, without any farther damage.

Celeſtial influences in the air.

Beginning to conſider the properties of vinous liquors, their ſeveral diſtempers, and the method to preſerve them, I found it previouſly neceſſary to make an exact ſcrutiny into the air, its qualities, temper, and motion; with the influence it has upon all ſuch bodies. This led me into ſome thoughts, relating to the imperfection of our preſent theory of the planets. 'Tis certain, if this theory be not built upon a demonſtrable foundation, differences and errors will happen in our opinions of the motions of the planets, and the calculations of their places. But if we err in this reſpect, their ſeveral aſpects and influences cannot be juſtly determin'd; and conſequently, the phyſical uſe of theſe celeſtial bodies is wholly loſt, or becomes very uncertain.

a new uſe aſtronomy.

And truly, if aſtronomy cou'd not afford ſome aſſiſtance in aſcertaining the affections, diſpoſitions and alterations of ſeveral things here below, I ſhould grutch all the time and coſt; all the watchings and obſervations it requires. Several objections, indeed, are commonly produced, againſt any ſuch uſe or application to be made of this ſcience, and againſt the influence of the celeſtial bodies. But theſe chiefly proceed from the impoſture and ignorance generally found in the profeſſors of this ſcience; the palpable miſtakes, and great uncertainties as to predictions, under which it labours; and laſtly, from want of knowing the manner wherein the celeſtial bodies may affect each other. Such objections, however, if throughly conſider'd, do not, as I apprehend, make againſt the poſſibility of the thing, but wholly ariſe from the enormities and imperfections thereof; and theſe bodies may ſtill have a power to cauſe ſuch particular motions and alterations, as, in their extremes, will render themſelves univerſally perceptible. And this appears by undeniable experiments, not only in vegetables, but in animals, and that both in acute and chronic diſtempers; more particularly in lunatic, epileptic, paralytic, or lethargic patients. This is further demonſtrable, if the extreme motions in phyſics, be generation and corruption, and rarifaction and condenſation the mean ones; for allowing theſe bodies a ſhare in promoting the latter, their effects upon all other ſublunary things muſt be very conſiderable. Generation and corruption are, properly ſpeaking, the extremes of motion, rather than motions themſelves; for the deſign and effects of all phyſical motion, are, in ſtrictneſs, either generation or corruption; and all motion is hereby limited and bounded; for beyond theſe there is no phyſical progreſſion; ſince all things are corrupted to be generated, and *vice verſâ*. It muſt then be acknowledged, that nature makes uſe of motions between theſe two extremes; which mean ones muſt alſo be as oppoſite to each other, as the two extremes. And as the motions of rarifaction and condenſation are oppoſites, ſo they fall in with all the other inſtruments and phenomena of nature; the one correſponding to heat, the other to cold; the one to hardneſs, compactneſs and dryneſs; the other to ſoftneſs, ſweetneſs, maturity, *&c.* For theſe, among many other reaſons, I conclude, that generation and corruption, rarifaction and condenſation, are the ſimpleſt, plaineſt, and juſteſt analyſis, in nature, of all phyſical motions; ſince all motion purely phyſical, may, with eaſe, be immediately referr'd thereto, and reſolved therein.

'Tis evident, that all the properties of moiſture, heat, cold, droughts, winds, ſhowers, thunder, *&c.* employ'd by nature to produce the two univerſal effects, rarifaction and condenſation, almoſt wholly depend upon the courſe, motion, poſition, ſituation, or aſpect of the celeſtial bodies. Thus every planet has its own proper light, diſtinct from that of the others; which is either a bare quality, and then its utmoſt uſe and deſign is only to illuminate; or elſe all light is attended with ſome peculiar power, virtue, or tincture; whence 'tis plain, that every light has its peculiar property, tincture, and colour; its own ſpecific virtue and power, wherein the planets differ from each other; and conſequently the celeſtial bodies are not to be conſidered as ſluggiſh and unorganized matter; but as full of their proper motion, operation, and life. Thus, the ſun not only ſhines upon all the planets, but by his genial warmth calls forth, excites, and raiſes the motions, properties, and powers peculiar to them: whence, according to the angle they make with that grand luminary, and the degree wherein they are enlightened, either by its direct or oblique rays, in a near or remote ſituation in reſpect of the earth; the effects of the powers, virtues, and tinctures proper to each, muſt be more or leſs perceived by us. As for the manner wherein the planets tranſmit their powers, and thereby affect the remoter bodies, 'tis not difficult to apprehend it; for we affirm no virtue or power to flow from the planets, that comes not along with the light as a property thereof.

'Twas never imagin'd that any of the planetary or ſolar light is refracted, or otherwiſe weaken'd or diminiſhed by the æther, thro' which it paſſes; and conſequently 'tis not hinder'd from deſcending with its full force, directly and unrefracted, upon our atmoſphere. But whatever is received by the atmoſphere, muſt alſo be received by the thin and ſubtile air that is contiguous thereto; which air is, doubtleſs, capable of being moved, agitated, altered, and impreſſed by the properties, virtues, and lights that penetrate all its parts. Not only ſo, but our ſpirits alſo, with thoſe of all mixed bodies, will receive no leſs impreſſion, alteration, motion, agitation, and infection from the ſame lights; nay, as our ſpirits approach nearer to the nature of light than that of air, ſo will they be more affected thereby. And if the ſpirits, we ſpeak of, may be altered, changed, moved and impreſſed by theſe ſuperior bodies, and their properties; ſince ſuch ſpirits are the only principles of action, power, force and life in the bodies, wherein they reſide, and the immediate cauſes of all the alterations therein, 'tis impoſſible they ſhould be altered and changed, and the reſpective bodies remain unaffected thereby; conſequently the force of the ſuperior bodies muſt exert a power or operation on the very ſubſtance of the inferior. To confirm this, in particular, with regard to our ſelves, we might have recourſe to the miſchiefs that frequently befal mankind by means of the air, which ſeems no otherwiſe concern'd; ſuch are convulſions, cramps, blaſts, lameneſs, colds, *&c.* many whereof have a long duration, tho' rarely felt at the very inſtant of their approach, or attended with any perceptible exceſs of heat or cold.

As the other planets, ſo alſo our earth is not only enlightened, warm'd, cheriſh'd, and made fruitful by the power, virtue, and influence of the ſun; but it hath, moreover, its proper, magnetical, planetary force awaken'd, fermented, excited, and agitated; which it ſends back with the reflected light of that luminary. By this means alſo, the ſeminal diſpoſitions, odours, and ferments, lodg'd in particular regions and parts hereof, at the ſame time emit and diffuſe thro' the air either their kindly and grateful, or malignant, congeling, and putrefying qualities. Hence, tho' the temper, diſpoſition, and general qualities of the air may be aſſigned according to the motions, influences, and aſpects of the ſeveral ſuperior planets, yet the particular healthfulneſs and unhealthfulneſs of places; the bad diſpoſitions of the air, whether in the evenings, nights, or mornings; in ſome parts more than others; exceſſive moiſture, great winds, droughts, or ſeaſons peculiar to a country, ſhould chiefly be aſcribed to thoſe odours, vapours, and exhalations, that by the action of the ſun, or other planets, are forc'd from their particular ſeats in the planets themſelves into the air. Now if this be the ſtate of the caſe, it follows, that wholly to neglect ſuch a phyſical uſe of the motion of theſe bodies, becauſe ſuperſtition has crept into it, is very extravagant; and ought not to paſs uncenſur'd in men of learning.

In this apology for aſtrology, I, by no means, pretend to juſtify any thing farther than as it properly, or of neceſſity, falls under natural philoſophy; but I greatly ſuſpect, that if the theory of the planets were ſo well adjuſted and ſettled, by demonſtration, that we exactly knew the place, courſe, and poſition of every one of them; the doctrine of their phyſical uſe, with its weight, dignity, extent, and moment, would immediately become ſelf-evident; eſpecially if particular perſons would calculate the motions here to their own reſpective meridians, and compare them with their own daily obſervations of the alteration of the air. As this was, doubtleſs, the method firſt taken by the antients, to diſcover the efficacy of theſe bodies, by giving an hiſtorical diary of the weather and places, motions and aſpects of the planets, with their agreement, diſagreement, &c. the ſame procedure could not but prove ſatisfactory and delightful in the momentous doctrine we ſpeak of. And were ſuch a plain demonſtration of the power of theſe bodies, in general, once eſtabliſhed, the uſefulneſs of this ſcience in civil and œconomical affairs; in huſbandry, gardening, and phyſic; and the ſhare they have in producing many other very ſurprizing effects, would be eaſily diſcern'd and credited. The preſent age ſeems better furniſhed than was ever any preceeding one, to lay ſuch a foundation by means of thoſe extraordinary inſtruments the thermometer and barometer. And no man, who hath leiſure and opportunity, ſhould think it trifling to collect obſervations of this nature: 'tis certainly much more commendable to preſerve this kind of hiſtory of our own time, than to break out upon every occaſion; "This is the "hotteſt, this is the coldeſt, this is the moſt ſeaſonable, this is the moſt "unſeaſonable weather I ever felt;" when perhaps it's utterly falſe in fact. Did no other benefit accrue from theſe obſervations, they would tend to complete the natural hiſtory of any place; an inſtance whereof we

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mended.

The defects of the thermometer.

we have in that learned author, who has given us the natural hiſtory of *Braſil*; wherein he proves not only the habitableneſs, but healthineſs of the climate, by a particular account of the weather of every day, for many years together. 'Twould be a noble undertaking to promote the perfection of a ſet of accurate obſervations hereto relating, by means of various large and exact thermometers, conveniently expoſed, either ſeparately or conjointly, to the air. 'Tis greatly to be lamented, that no advantage has been made of this inſtrument ſince its firſt invention. Many things, indeed, are wanting to its perfection; for the beſt proportion between the diameter of the cylinder and that of its head, is hitherto unknown, which ought to be the firſt conſideration here; and till this be adjuſted, there is danger of erring in making either too large for the other; whence the alterations of the air will be too ſuddenly or too ſlowly diſcernable. But ſuppoſing the due proportion in this caſe aſſign'd, we are at a loſs as to the length of the cylinder, which ſhould, doubtleſs, correſpond to its diameter; the ſmalleſt tube in proportion to its head, requiring the greater length, and *vice verſâ*; only twelve or ſixteen degrees are uſually placed on the ordinary glaſſes, but to make accurate obſervations, the cylinder ſhould, at leaſt, be divided into 360 parts: nor is it impracticable to divide one into 1000, allowing 10 degrees to an inch; and this would diſcover not only the minute, but the more ſudden and remarkable changes of the weather, much better than thoſe in common uſe. No liquor, 'tis certain, ſhould be applied in theſe glaſſes that is ſubject to freeze, yet have we but a very imperfect account what fluids are beſt fitted for ſuch experiments; whether thoſe which attract the air, and thereby preſerve their quantity, as *Oleum Sulphuris per campanam*, *Vitrioli*, *Tartari per deliquium*, &c. or thoſe, the parts whereof are exceeding fine and ſubtile, and give them a reſemblance to the air; ſuch as ſpirit of wine, and ſpirit of tupentine well rectified, and ſupplied occaſionally; whether thoſe of a middle nature, as ſtrong ſpirit of vinegar; or laſtly, whether only well refined quickſilver. All theſe particulars muſt be ſettled as neceſſary preliminaries to the experiments themſelves; in the making whereof 'tis convenient, that ſeveral glaſſes, alike in all reſpects, ſhould be placed together in one frame, and filled either with the ſame or different liquors; and ſeveral of theſe frames placed in various rooms, and ſome expos'd immediately to the air it ſelf; but ſkreened from the ſun's rays and the injuries of the weather. Too great care and exactneſs cannot be uſed in the hiſtory it ſelf; the air of the chimney, cracks in the wall, the breath of people, *&c.* if not regarded, will diſturb theſe obſervations. The degrees of warmth of the day and night, in ſettled weather; the agreement or diſagreement of the air's motion, and that of the ſuperior bodies, in changeable and unconſtant weather; the certainty or uncertainty of thoſe motions, in foretelling winds and rain; the diſpoſitions of the air in thunder, mildews, blaſts, eclipſes, conjunctions, *&c.* will afford matter for this hiſtory. What other things are performable by the thermometer, I ſhall not now conſider; but 'tis certain, that the great mechanic, *Cornelius Drebel*, did herewith contrive a dial, which had a continual, ſpontaneous, and regular motion, whereby it exhibited not only the times of the day, but alſo the celeſtial appearances; that he alſo made an automatous, muſical inſtrument, and a furnace which he could regulate to any degree of heat, by means of the ſame inſtrument.

'Tis an approved tradition in *Java*, that the moon's rays will cauſe contractions in the bodies of thoſe who are long expoſed thereto. And an ingenious phyſician, who had practiſed there, aſſured me, he obſerved ſome perſons become lame by this means; and ſo continue for many weeks, or ſometimes months together. He alſo experienced it upon himſelf; for happening, whilſt he was a ſtranger in that country, to ſleep, after a very hot day, for a conſiderable time on the ground, that lay fully expoſed to the moon; upon waking he found his neck exceeding ſtiff, and his mouth drawn awry in an hideous manner; which obliged him to keep within doors, till by the uſe of briſk aromatic medicines, he freed himſelf from that diſorder. The coldneſs of the night, and the ſubtilty of the air, he ſaid, were not the ſole cauſe of theſe phenomena; the effects of thoſe generally proving lighter, if the moon be unconcern'd.

An intelligent perſon having by a fall ſo broken his head, that ſeveral large pieces of his skull were obliged to be taken out, he aſſured me, that for ſeveral months, during which he lay under the ſurgeon's hands, he conſtantly obſerved, that about full moon, there would be extraordinary prickings and ſhootings in the wounded parts of his head, as if the meninges were ſtretched, or preſſed againſt the rugged parts of the broken skull; and this with ſo much pain, as wou'd for 2 or 3 nights hinder his ſleep, of which at all other times of the moon he uſed to enjoy a competency. This gentleman added, that his ſeveral ſurgeons, for he had 3 or 4 at once, obſerved from month to month, as well as he, the effect of the full moon upon his head; informing him, that they then manifeſtly perceived an expanſion, or intumeſcence of his brain, which appear'd not at all at the new moon; nor was he then obnoxious to the forementioned pricking pains.

Motions of e air.

From a letter, dated *Fort St. George*, Jan. 23. 1668. "There happen'd "a dreadful ſtorm, or rather hurricane here, on the 22^d^ of *November*, "when a tempeſt of wind and rain grew ſo exceeding violent, that "nothing was able to ſtand againſt it. Men and beaſts were thereby "ſwept away together into the ſea; few houſes or trees eſcaped its "force; the wall of the town was laid flat in ſeveral places; the "buildings about the fort were uncover'd and greatly ſhatter'd; and "the fort it ſelf was ſo vehemently rock'd, that it ſeem'd ready to "fall upon us."

Captain *Brookehaven* told me, that hurricanes are very frequent about the iſland *Maufricius*; that he remembred one on the ſea not far from thence, which laſted four days; that upon one of them the ſtorm had ſeven paroxyſms, call'd by the ſailors, frights of weather, each whereof he obſerved to differ two points of the compaſs from the other ſucceſſively; and that by this means the ſurface of the ſea became a white froth. This ſtorm occaſion'd the day to be exceeding dark, and the noiſe it made ſeem'd more like that of thunder, than of wind; which was ſo loud, that thoſe on the deck of the ſhip cou'd not hear thoſe on the ſhrouds.

A phyſician who had been in *America*, aſſured me, that none but the hilly part thereof had conſtant winds from the land in the night time; and that, therefore, *Barbadoes* was without them.

One of the *Eaſt-India* committee, who had lived in the iſland of *Teneriff*, told me, he uſually obſerved the breezes there to proceed from the ſea, about nine of the clock in the morning; and that, two hours after the ſun-ſet, there blew a ſharp, land gale from every part of the iſland towards the ſea, which continued all the night.

A learned traveller acquainted me, that tho' the air were generally calm and clear on the tops of the mountains; yet he had ſometimes there met with winds conſiderably ſtrong.

In a letter from *Venice*, dated *Auguſt* 29th 1679. " There aroſe a kind of whirlwind in the fens of the city *di Favis*, three miles diſtant from *Palma*; which ſpreading about 50 paces in breadth, ſwept along with ſuch fury, that it carried up into the air ſeveral hay-makers in the neighbouring meadows, with loaden waggons, horſes, oxen, and all; caſting 'em down a large diſtance off, ſhatter'd and ruin'd. In its progreſs it tore up all the herbs and plants it met with, and even pared, and burnt the turf. At its arrival in the little *Venetian* town *Bagnaria*, it overturn'd ſeveral houſes to the very foundations, and uncover'd others; hurrying along with it beams, pillars, tables, and all the furniture and moveables, and bruiſing many perſons, tho' without killing any. It ſtript the church S. *Thomaſo*, near the town, quite bare; carrying away the very ſteeple and bells, which were not yet found the next day. Hence it turn'd towards *Sevigliano*, where it deſtroy'd the whole champaign, tho' without doing any damage to the town. A little farther it threw down the palace of the Count *Horatio Straſoldo*, and took away with it in the air various kinds of animals and moveables, and even the very veſſels out of the cellars: yet no body was hurt, the family being moſt of them at work in the fields. In its way to *Straſoldo* it threw down two other houſes, killing therein a lady, a young man, and ſeveral beaſts. Hence turning towards *Palma*, and arriving at the walls of the fort, on the ſide of the city *Privano*, it beat it to pieces, overturn'd ſome very fine palaces, killing ſeveral perſons, and wounding others; and doing great miſchief to the

“ grounds. It then advanced to the city *di Viſco*, belonging to the Emperor, where, among other conſiderable damages, it ruin'd the new palace of *Marco Foſcolini*, wherein was a large coach-houſe, the door whereof was faſten'd by three bolts; but the wind entering in at the balcony, burſt open the door, ſhatter'd it to pieces, and threw it upon a high court-wall, carrying the ceiling of the room half a mile further; wounding ſome of the ſervants, and killing two perſons in the ſtreets. This done, it attack'd S. *Vido di Crauglio*, a town belonging to the Emperor, which it ruin'd entirely, ſo as not to leave a ſingle houſe; killing and wounding great numbers. Hence it proceeded to *Villes*, a great part of which it levell'd with the ground; deſtroying men and other animals, and leaving the fields as bare as a beaten way. Other towns have ſuffer'd from it in a like manner, tho' in a leſs degree.”

I learnt from a phyſician, that tho' the eaſtern winds blow near three quarters of a year at *Tangier*; yet they ſeem not to ſpread far into the inland country, becauſe he found them there to be very unfrequent.

An ingenious gentleman, who poſſeſſes a mine or two near the ſea, inform'd me, that he cou'd preſage the change of wind, at the depth of between 15 and 20 fathom in 'em. For, many hours before it veer'd from any other point to the ſouth, the water at the bottom of the mine would appear thick; and when 'twas upon changing to the eaſt, the water became unuſually clear.

The hurricanes about *Goa*, as the ſame gentleman ſaid, generally happen but at two ſeaſons; *viz.* about the beginning of *March* and of *October*.

Prognoſtics hurricanes Bermudas.

The late governor of the *Bermudas* iſlands inform'd me, that theſe were of the principal forerunners, of the hurricanes there. The ſea would manifeſtly ſwell at ſome diſtance from the ſhore, ſo that the fiſhermen often made to land, and warn'd the inhabitants, upon the confidence of that preſage, to provide againſt the ſtorm, tho' the ſea were then ſmooth enough. The ſea would beat with great noiſe againſt the ſhore, eſpecially the rocks, tho' there appear'd no manifeſt cauſe for it, as upon account of the wind or tide: and this ſign would ſometimes not be given till many hours, or perhaps a full day after the former. Sometimes alſo 'twas obſerv'd, that the ſea would ſuddenly invade the ſhore, and gain further upon it than could be accounted for by the wind or tide, and then quickly ebb away beyond the uſual low water-mark, and after return again with more fury, and fall back further than before. Sometimes there would be perceiv'd an ungrateful ſmell in the air, before the hurricane began. And laſtly, he affirm'd, that both he and others had ſeen in the air many bundles, as it were of long ſtreaks of different colours; which by reaſon of their figure are uſually there call'd horſe-tails: and theſe appear'd in ſuch parts of the ſky, where the air was troubled indeed, but no form'd clouds were viſible.

A gentleman told me, that being off the coaſt of *Moſambique*, towards the latter end of *September*, the captain of the great *Portugal* ſhip wherein they were, ſpied, as he walked upon deck, a very little dark cloud, or blackiſh ſpot in the sky, a great way off; upon which, tho' the weather was then fair, he immediately provided for a ſtorm; and when the cloud approached, the wind, which before had filled their ſails, ceaſed, and the ſea became calmer than before; but preſently after they had a furious hurricane, which ſeveral times turn'd their ſhip quite round; and laſted for above two hours.

The air's operation on the ſounds of bodies.

“ When ſeveral tempeſts riſe together, the sky is of a ſudden cover'd over with thick, black, globular and ſmoky clouds; when immediately the thunder burſts out on every ſide with inceſſant flaſhes of lightning, able to ſtrike terror into the moſt reſolute, and thoſe accuſtom'd thereto.” *Ludolf*'s Hiſt. of *Æthiop.*

The ſtring of a viol has by a gentleman been obſerved to increaſe the ſharpneſs of its ſound by almoſt half a note, either a little before, or in rainy weather. The ſame perſon alſo aſſured me, that having put falſe ſtrings into his pocket for frets, he has ſometimes, when he came to make uſe thereof, found them true. He further obſerves, that ſome ſtrings are apter to receive a tenſion from the moiſt air than others.

An ingenious and credible perſon aſſured me, that in one of the fine gardens near *Genoa*, there is a pond on the ſide of a hill, where the wall being ſo high, that men could not look over it, nor be at all ſeen over it by the fiſh in the pond; yet that he has ſeveral times obſerved thoſe fiſh to be called together by the gardener, with a certain noiſe he made for that purpoſe; tho' neither this gentleman, nor any one elſe, could be diſcover'd by the fiſh that readily obey'd the ſummons.

The weight of the air, with its effects.

The different weight of the atmoſphere at different times may perhaps have a conſiderable influence on the human body, with regard to health and ſickneſs. Thus, when the air grows of a ſudden much lighter than uſual, the ſpirituous and aerial particles plentifully lodged in the blood, will naturally ſwell that liquor; and ſo diſtend the greater veſſels, and alter the manner of the circulation thro' the capillary veins and arteries: whence ſeveral changes may happen in the body.

Having three ſmall, round glaſs bubbles, blown at the flame of a lamp about the ſize of hazel nuts, each of them with a ſhort, ſlender ſtem; by means whereof they were ſo exactly poiſed in water, that a very ſmall change of weight wou'd make them either emerge or ſink; at a time, when the atmoſphere was of a convenient weight, I put them into a wide mouth'd glaſs of common water, and leaving them in a quiet place, where they were frequently in my eye, I obſerved, that ſometimes they would be at the top of the water, and remain there for ſeveral days, or perhaps weeks together; and ſomeist. times fall to the bottom; and after having continued there for ſome time, riſe again. And tho' ſometimes, eſpecially if I removed the containing veſſel to a ſouth window, they wou'd riſe or fall as the air was hot or cold; yet theſe motions were eaſily diſtinguiſhable from thoſe produced by the varying gravity of the atmoſphere. For when the ſun-beams, or the heat of the ambient air, by rarifying the air included in the bubbles, cauſed that air to drive out ſome of the water, and conſequently made them ſpecifically lighter than water, tho' the bubble neceſſarily floated whilſt the included air was thus rarified; yet when the abſence of heat cooled, and conſequently condenſed the air, more water being intruded into the bubble, it muſt neceſſarily ſink; and this wou'd commonly happen at night, if not before. But when the bubbles either roſe or fell, by means of the different weight of the atmoſphere, it appear'd, by the barometer, that the atmoſphere was ſo heavy, or ſo light, as to be the cauſe thereof. So that I could often foretel the ſtation of the mercury in that inſtrument, from the phenomena of theſe bubbles. And tho' whilſt the atmoſphere was not conſiderably either too light or heavy, the changes of the air, as to heat or cold, wou'd affect the bubbles, and make them often change places in the compaſs of a day; yet if the atmoſphere were either very heavy or very light, the bubbles wou'd continue at the top, or the bottom of the water, for many days together; whilſt the atmoſphere did not change its gravity. And once, when the mercury ſtood high in the barometer, I ſet the glaſs for two or three days in a ſouth window, about noon, in ſun-ſhiny weather; yet even then the bubbles did not emerge; tho' it appear'd by a good ſealed weather-glaſs, kept in the ſame window, that the ambient air was much warmer, than at other times, when the bubbles had reſted on the top of the water. It being very difficult to poiſe ſeveral bubbles exactly, one as well as another, 'twas no ſurprize to me that all the three bubbles did not conſtantly riſe and fall together. 'Twere, therefore, proper to poiſe a great number of bubbles together, that after trial made of all, the fitteſt might be choſen for this purpoſe. Sometimes a bubble that floated when firſt poiſed, wou'd after a while ſubſide, without any manifeſt cauſe; or if made to ſink by ſuch a cauſe, wou'd continue at the bottom after that cauſe was removed; which ſeemed to depend upon the water's imbibing, as it were, certain aerial particles. The experiment, however, did ſometimes anſwer expectation; which ſhews, that as the atmoſphere is heavier or lighter, 'tis able to affect bodies under water; ſo that the air muſt preſs upon the water it ſelf, by the intervention whereof it exerciſes its power; whence conſequently the atmoſphere is incumbent, as a heavy body, upon the terraqueous globe.

tical r. Making choice of a large, thin, and light glaſs bubble, blown at the flame of a lamp, I counterpoiſed it with a metalline weight, in a pair of ſcales that were ſuſpended in a frame, and wou'd turn with the 30th part of a grain. Both the frame and balance were then placed near a good barometer, whence I might learn the preſent weight of the atmoſphere; when, tho' the ſcales were unable to ſhew all the variations that appear'd in the mercurial barometer, yet they gave notice of thoſe that alter'd the height of the mercury half a quarter of an inch; and if the ſcales had been more tender, and better accommodated, much ſmaller alterations might, doubtleſs, have been diſcern'd. By this means, however, the bubble did ſometimes balance the weight, and ſometimes this wou'd greatly preponderate; and that for different ſpaces of time, as the weight of the air continued. And thus the matter of fact was eſtabliſh'd by repeated obſervations and compariſons, made with ſeveral of theſe new barometers together. The foundation of this invention is as follows. The glaſs bubble, and its counterpoiſe, tho' at firſt exactly of the ſame weight in air, are very different as to bulk; the bubble being perhaps two hundred times bigger than that. And if two bodies of equal gravity, in a certain medium, but of unequal bulk, be weigh'd in a different medium, they will no longer balance each other; if the new medium be the heavier, the larger body, becauſe ſpecifically lighter, will loſe more of its weight than the leſs and more compact. But if the new medium be the lighter, the larger body will overbalance the leſs. And this difference ariſing from the change of the medium, will be proportionable to the inequality in the bulks of the originally equiponderant bodies. Hence it muſt prove the ſame thing, as to the effect, whether the bodies be weigh'd in mediums of different gravity, or in the ſame medium, whoſe ſpecific gravity conſiderably alters.

Since, therefore, it appears, by the barometer, that the air is ſometimes heavier, and ſometimes lighter, its alterations in this reſpect muſt unequally affect a large, hollow bubble, and a ſmall, denſe weight, once balanced in a pair of ſcales; ſo that when the air grows heavier, it muſt buoy up the glaſs more than the counterpoiſe; and when lighter, ſuffer that to preponderate. The glaſs bubble here employ'd was hermetically ſealed; being equal in bulk to a large orange, and in weight one dram and ten grains. 'Tis poſſible to procure one more convenient than this, if care be taken not to ſeal it up whilſt hot; for by that means the internal air being rarified, the glaſs will be eaſily broke by the force of the external. Two ſmall bubbles, which are eaſily procured, may, upon occaſion, ſerve inſtead of a large one, which it may prove difficult to obtain.

This inſtrument is improveable in ſeveral reſpects. A graduated arch of a circle might be fitted to the top of the balance, for the point of the cock to play in; and by that means readily give the angles from its perpendicular poſition. A gold weight may be ſubſtituted for one of braſs. The ſeveral parts of the balance being made of copper or braſs, will be leſs ſubject to ruſt than ſteel. Inſtead of ſcales, the bubble may be hung at one end of the beam, and the weight at the other. If the whole inſtrument, placed in a ſmall frame, be included in a glaſs, open at the top, to admit a free paſſage to the air, 'twill be thereby preſerved from ruſt and irregular agitations. A light wheel and an index would enable it to ſhew very minute variations. And, laſtly, a proper length of beam, and an exquiſite balance, may, alone, render this inſtrument far more exact than thoſe I was reduced to employ. In ſome reſpects, indeed, the ſtatical is inferior to the mercurial barometer; but in others it has peculiar advantages. As for inſtance, it firſt demonſtrates to the eye, that the riſe and fall of the quickſilver in the common ſort, proceeds from the different weight of the atmoſphere; for it cannot here be pretended, that an abhorrence of a vacuum, or a funicular power, is the cauſe of the variation. And 2. that the air is a more ponderous body than ſome learned men will allow. 3. 'Twill frequently be found more eaſily procurable than the other. 4. 'Tis very portable, and little liable to accidents, in removing it from one place to another. 5. Here is no uncertainty as to its goodneſs, as in the mercurial kind; where the air may be more or leſs excluded. 6. Both the abſolute and reſpective weight of the air is hereby nearly diſcoverable; for 'tis eaſie to find hydroſtatically the bulk of the bubble, and the contents of its cavity, with the weight and dimenſions of the glaſs whereof 'tis compoſed; if the ſcales, therefore, be brought to an equilibrium, by ſmall weights, when the mercury in the common barometer, is either very high, or very low, or elſe in a medium between both, obſerve when the quickſilver, either riſes or falls, for inſtance, an inch, and then by adding weights to the aſcending ſcale till the beam again becomes horizontal, you'll find what weight anſwers that determinate riſe or fall of the mercury: and if the balance be furniſhed with a graduated arch, or a wheel and index, theſe obſervations may ſerve, for the future, readily to ſhew how much the bubble gains or loſes by a change in the weight of the atmoſphere. Some obſervations of this nature I carefully made, by adding a 64th, 32d, or a 16th of a grain to the lighter ſcale; but an accident hindred me from bringing them to perfection. 7. This inſtrument will farther aſſiſt us in comparing the mercurial barometers of ſeveral places, to make ſome eſtimate of the air's gravity there. For inſtance, ſuppoſe the bubble employ'd weighs juſt a dram, when the mercury ſtands at $29\frac{1}{2}$ inches; and that the 16th part of a grain is required to reduce the bubble to an equilibrium, when the mercury riſes an 8th above its former ſtation. Suppoſe alſo, that removing my inſtrument to another barometer, equally freed from air with the former, when, if the bubble here retains the weight of a dram, and the mercury ſtands at $29\frac{1}{2}$ inches, we may conclude, that the weight of the atmoſphere is the ſame at both places; how remote ſoever they may be. But in caſe there be no barometer at this latter place, yet if, by the 16th part of a grain ad-

added to the bubble, I bring the ſcale to an equilibrium, 'tis plain, that the air here is, at this time, ſo much heavier than that of the former place, when the mercury ſtood at 29 $\frac{1}{2}$ inches. But in ſuch compariſons regard muſt be had to the ſituation of the places, if we would eſtimate the weight and denſity of the air. For tho' this inſtrument will ſhew a difference of weight in the atmoſphere of two places, yet if one be a vale, and the other a hill, 'tis not to be expected that the atmoſphere on the latter, ſhould gravitate equally with that in the former, whereon a higher column of air is incumbent; and ſo the bubble have the ſame weight in both. The laſt uſe I ſhall mention of this ſtatical barometer is, its ſerving to find the difference of the air's weight at ſeveral heights. Thus, for inſtance, having exactly poiſed the bubble at the foot of a hill or ſteeple, and afterwards raiſing the frame to the top thereof, the weight there requiſite to reduce the beam to an horizontal poſition, gives the difference required. But how far this method may aſſiſt in eſtimating the abſolute and comparative height of mountains, *&c.* and what other applications may be made of the inſtrument, when duly improved, I leave to farther conſideration.

Obſervations and directions relating to the barometer.

It will be very convenient, that obſervers give notice of the ſituation of the place, where their barometers ſtand, not only, becauſe it will aſſiſt men to judge, whether the inſtruments were duly perfected, but principally, becauſe, that though the barometer be good, the obſervations will much diſagree, even when the atmoſphere is in the ſame ſtate, as to weight, if one of the inſtruments ſtand in a conſiderably higher part of the country than the other.

To confirm the foregoing admonition, I may ſay, that having two lodgings, the one at *Oxford*, which ſtands in a bottom by the *Thames* ſide, and the other at a place four miles thence, ſeated upon a moderate hill, I found by comparing two barometers that I made, the one at *Oxford*, the other at *Stanton St. Johns*, that, though the former be very good, and hath been noted for ſuch, during ſome years, and the latter very carefully fill'd; yet by reaſon, that in the higher place, the incumbent part of the atmoſphere muſt be lighter, than in the lower, there is almoſt always between two and three eighths of an inch difference betwixt them: and having ſometimes ordered my ſervants to take notice of the diſparity, and divers times carefully obſerved it my ſelf, when I paſſed to and fro between *Oxford* and *Stanton*, I generally found, that the *Oxford* barometer and the other, did, as it were by common conſent, riſe and fall together ſo, that in the former the mercury was uſually $\frac{1}{8}$ higher than in the latter. Theſe obſervations may teach us, that the ſubterraneous ſteams which aſcend into the air, or the other cauſes of the varying weight of the atmoſphere, do many times, and at leaſt in ſome places, uniformly enough affect the air to a greater height than, till I had made this tryal, I durſt conclude.

But as moſt of the barometrical obſervations are ſubject to exceptions, ſo I found the forementioned to be. For (to omit leſſer variations) riding one evening from *Oxford* to *Stanton*, and having before I took horſe look'd on the barometer in the former of theſe two places, I was ſomewhat ſurprized, to find at my coming to the latter, that in places no farther diſtant, and notwithſtanding the ſhortneſs of the time (which was but an hour and half, if ſo much) the barometer at *Stanton* was ſhort of its uſual diſtance from the other near a quarter of an inch; though the weather being fair and calm, there appeared nothing of manifeſt change in the air, to which I could aſcribe ſo great a variation; and tho', alſo, ſince that time the mercury in the two inſtruments hath, for the moſt part, proceeded to riſe and fall as before.

The quickſilver has been of late, for the moſt part, ſo high, as to invite me to take notice of it, and about *March* 12. $166\frac{7}{8}$ at *Oxford* the quickſilver was higher than, for ought I know, has been yet obſerved in *England*, *viz.* above $\frac{5}{16}$ above 30 inches; but upon the firſt conſiderable ſhowers, that have interrupted our long drought; as I foretold ſeveral hours before, that the quickſilver would be very low, (a bluſtering wind concurring with the rain) ſo I found it at *Stanton* to fall $\frac{3}{8}$ beneath 29 inches.

It is difficult enough to ſettle any general rule about the riſing and falling of the quickſilver; yet in theſe parts one of thoſe that ſeem to hold ofteneſt is, that when high winds blow, the mercury is the lower; and yet that it ſelf does ſometimes fail. *

The weight a cubic inch water, and quickſilver.

Having procured an exact, concave, cubic inch of braſs, and carefully balanced it in a nice pair of ſcales, by eleven drams one grain and a half, troy-weight, it was cautiouſly filled with clear, pump water, till the ſurface thereof appeared level with the upper edges of the metal; then weighing the water, it equall'd $254\frac{7}{16}$ grains; we may therefore, without any ſenſible error, ſuppoſe a cubic inch of water to weigh 256 grains; which agrees very well with ſome other experiments I made to diſcover the ſame. The metalline cube was afterwards dried and counterpoiſed afreſh, and filled as exactly as poſſible with diſtill'd mercury; the weight whereof, alone, we found to be ſeven ounces, two drams, troy; but by adding a little, without making it run over, the whole inch of mercury equall'd ſeven ounces, three drams, twenty two grains. The eye now placed in a level with the brims of the veſſel, diſcover'd the mercury a little above them; however, it ſtill received 112 grains more of mercury, without running over; and more, perhaps, might have ſtill been added. From hence it appears ſcarce poſſible to determine by this means, the exact weight of a cubic inch of quickſilver. And ſince by other trials I have found the weight of mercury to that of water, of the ſame bulk, in a ſomewhat leſs proportion than of 14 to 1; the weight of a cubic inch of quickſilver may well enough be ſuppoſed 3580 grains; and conſequently, when a column of quickſilver, thirty inches high, is ſuſtain'd in the barometer, as it frequently happens, a column of air that preſſes upon an inch ſquare near the ſurface of the earth, muſt weigh above fifteen averdupoize pounds.

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* 'Tis found that the mercury in the barometer deſcends upon violent guſts of wind; and Mr. *Hauksbee*, to ſolve the phenomenon, contriv'd an experiment, wherein an artificial blaſt of air ſo leſſened the preſſure of the atmoſphere, upon the ſtagnant mercury in the ciſterns of two barometers at once, that the columns ſuſtained, were thereby made to deſcend two inches; tho' one of the barometers was diſtant three feet from the ſtream of air. And hence 'tis very obvious, as Mr. *Hauksbee* obſerves, "that different forces and "different directions of the wind, may "produce different degrees of ſubſiding "in the barometer; and that ſtrong "winds may, by thus altering the preſſure "of air, greatly affect the animal œconomy." *Hauksbee's Experim.* p. 114—119.

What quantity of air preſſes upon a ſquare inch.

As 355 to 452, ſo is the area of a ſquare inſcribed in a circle, to that of the circle circumſcribed; whence 355. 452 :: 1. 1,2732394. If, therefore, the ſide of an inſcribed ſquare be an inch, that ſquare multiplied by another inch, gives an inch in ſolid meaſure. Thus if a cylinder, an inch in height, be erected upon the circle circumſcribed; the ſolid content thereof will be 1,2732394. Hence 1, and 1,2732394, being multiplied by the weight of a cubic inch of any metal, you have the weight of a cubic inch, and of a cylindrical one that circumſcribes the ſame; whence an inch table for both is eaſily made, by continual addition, or for any given height, if you multiply both thereby.

Fig. 2.

“ The ſyphon B O, was ſealed at the end O, but open at B; the
“ bend from G to C containing mercury, and the other parts nothing
“ but air. The diſtance from O to C was four inches, or $\frac{32}{8}$.
“ By heating the air, the mercury ſunk to F, $\frac{3}{8}$ lower than it ſtood
“ before, and at the ſame time roſe in the other leg to H, $\frac{5}{8}$ higher
“ than G or C. To find what height of mercury was required to
“ hinder the expanſion of the air, and continue the mercury at C,
“ we need only try how much wou'd ſerve to force it back again
“ to C; and thereby retain the air in the ſpace O C, notwithſtanding
“ the force of the heat. I ſuppoſe it known from experience,
“ that when a quantity of air poſſeſſes any ſpace, which we call A,
“ and the force, B, that retains it therein, be increaſed in any degree,
“ ſuppoſe it X, the ſpace A will be thereby diminiſh'd in a certain
“ quantity D, which is to the remainder M, as X to B, thus, D. M ::
“ X. B. and conſequently M. D :: B. X. This rule may be eaſily applied
“ to our preſent experiment; for herein O F, $\frac{35}{8}$ inch, is the
“ ſpace A; and the uſual preſſure of the air, equal to thirty inches of
“ mercury, added to the one inch between F and H, anſwers to B and
“ X, or thirty one inches of mercury; and if a proper quantity be
“ added to reduce the air into the ſpace OC, the ſame OC, will be
“ M, $\frac{32}{8}$ and FC, be D, $\frac{3}{8}$; whence the three quantities $\frac{M.\ D :: B.}{32.\ 3 :: 31.}$ are
“ given

" given to find a fourth proportional, 2 $\frac{22}{32}$ which added to B, 31, " make 33 $\frac{22}{32}$ inches, whereby the air is forced into CO, that is, near " 4 inches more than the ordinary preſſure."

" A ſufficient number of exact ſurveying chains, being fix'd to a " well-purged barometer, conveniently framed; the mercury ſtanding at " 30 inches and 50 cents; we drew it up to the firſt floor of *Sarum* ſteeple, " 1033 ½ inches from the pavement, when the quickſilver was ſunk 9 " cents; then raiſing it to the middle floor, that is, 935 inches above the " former, it fell 8 cents lower; and when arrived at the weather door, " that is, 2313 inches ſtill higher, it ſubſided 23 cents more. The " whole height was therefore 4281 ½ inches, and the whole difference " of the mercury's ſinking, 40 cents of an inch. Upon letting down " the barometer to the ſame places, the quickſilver ſeverally roſe to its " former ſtations."

" At another time we uſed an inverted barometer in the like manner; when the fluid of it roſe therein as follows. Fig. 3.

	Inches		*Inches*	*Cent.*
At the height of	1033 ½	The liquor aſcended	1	25
	1968		2	39
	2467		3	22
	4281		5	64
	4800 or the top.		6	40

At a place on the great continent of *Europe*, but not far diſtant from the ocean, a learned acquaintance of mine lately obſerv'd the mercury in his barometer, the weather being calm and ordinary, to riſe ſuddenly above two inches higher than the uſual ſtandard; which phenomenon was, in a few hours, followed by a prodigious and deſtructive ſtorm, that blew from off the continent. The ſame gentleman obſerves, that when ſtorms here blow from the ſea, which lies to the ſouthward, the quickſilver ſinks conſiderably; as hath alſo been obſerved in *England*, by an ingenious perſon, who lives near two leagues from the ſea. One whom I bred up to chymiſtry, was a few days ſince, ſurprized, to find the mercury in his barometer at *Oxford*, ſink on a ſudden greatly, while the weather continued fair and warm. The day, in four or five hours after, was overcaſt, and there happen'd a dreadful ſtorm of rain, lightning, and thunder; with ſuch a ſtrong whirlwind as had ſcarce ever been remembred in that city.

In a letter from Mr. *Locke*. " The deepeſt gruffs or pits I could hear " of at *Minedeep*, were about 30 fathom, but the deſcent into them " is ſo exceeding difficult, dangerous, and impracticable to a ſtranger, " that I durſt not then attempt to go down with a barometer; for they " are not ſunk like wells perpendicularly, but as the cranies of the " rocks happen to run. The conſtant method is, to ſwing down by a " rope placed under the arm, and clamber along by applying both

“ feet and hands to the ſides of the narrow paſſage. When damps
“ happen herein, if the miners cannot get out, they ſoon faint and die:
“ but if they be ſeaſonably drawn up, a hole being dug in the
“ ground, their faces are placed therein, and covered cloſe up with
“ turfs; which is the ſureſt method they have hitherto found to recover
“ them. After the uſe of fire in their pits, they find it very
“ dangerous to deſcend, as long as any heat remains in the clefts of
“ the rocks. Air is convey'd into them thro' a little paſſage that
“ runs along the ſides from the top; where they ſet up ſome turfs
“ on the lee ſide of the hole to catch and force it down. Theſe turfs
“ being removed to the windy ſide, or laid over the mouth of the
“ hole, the miners below preſently want breath, are indiſpoſed, and
“ faint: and if ſweet flowers chance to be there, they immediately
“ loſe their fragrancy, and ſtink like carrion. Being unable at this
“ time, to make any experiment with the barometer in theſe gruffs,
“ I carried it to the top of a high hill adjoining; when the mercury,
“ which below ſtood at $29\frac{1}{8}$ inches, was now ſunk to $28\frac{1}{4}$ inches. In
“ aſcending and deſcending, I found the quickſilver to fall and riſe
“ proportionably to the height where I ſtood. But at my return to
“ the foot of the hill, it wanted $\frac{1}{12}$ inch of the ſtation it there had
“ before; which I impute to the rarifaction of the air remaining in
“ the upper part of the tube.”

The king was lately pleaſed to tell me, that taking water from *Whitehall*, to ſail towards the river's mouth, in exceeding fine weather; upon which being congratulated by the courtiers, his majeſty bid them prepare for a ſtorm; which, in a few hours, happen'd accordingly; and drove vehemently upon the yatch for ſeveral leagues together. The king, before he went on board, had privately obſerved the mercury in a good barometer, to ſink very remarkably.

“ Since the water in pumps, and the external air, mutually balance
“ each other, they muſt have the ſame weight; whence if the height
“ whereto water riſes in any part of the world be known, by what
“ weight of the incumbent air that part is preſſed, will be known
“ alſo; and therefore, the places by the ſea ſide are preſſed by the
“ weight of the whole incumbent atmoſphere, as much as they wou'd
“ by a column of water 31 feet 2 inches high; thoſe that riſe ten
“ fathom above the former, as much as if they ſuſtain'd one of 31 feet,
“ 1 inch; and thoſe that lie 500 fathom higher than the ſea, are
“ preſſed as by a column of water of 26 feet, 11 inches, *&c.* Hence
“ it appears, that the air which ſtands above the level of the ſea, is
“ equal in weight to water 31 feet, 2 inches high: but becauſe air is
“ lighter upon places above that level, and therefore preſſes not all
“ the points of the earth equally; and being alſo of different weights
“ in different places, there is no certain rule to determine the exact
“ quantity of air, whereby, one with another, all the parts of the world
“ are preſſed. This, however, may be tolerably done in a conjectural

“ way; for example, by ſuppoſing, that if all the parts of the earth
“ were equally preſſed with air, 'twou'd be the ſame as if they ſup-
“ ported water to the height of 31 feet; and 'tis certain we cannot
“ err half a foot in this ſuppoſition. But we have ſeen, that the air,
“ at the height of 500 fathoms above the ſurface of the ſea, is equal
“ in weight, to water 26 feet, 11 inches high; and conſequently, the
“ air, from the ſurface of the ſea to that height, weighs as much as
“ water of 4 feet and an inch high; that is, near a ſeventh of the
“ whole height; whence 'tis plain, that the air between the ſea and
“ the ſame height, is nearly a ſeventh part of the whole atmoſphere.

“ 'Tis known alſo, that the vapours collected in the air, weigh,
“ when moſt numerous, no more than water of a foot and eight inches
“ high; ſince that additional height of water will balance them in
“ pumps: ſo that were all the vapours that hang over a whole
“ country to deſcend in rain, they would only make that quantity of
“ water; for if more happens to fall, it's owing to the winds driving
“ the vapours thither from other parts. Hence, likewiſe, it appears,
“ that if the whole atmoſphere was preſſed againſt the ſurface of the
“ earth, by a force applied to its upper ſurface, and thereby reduced
“ to the denſity of water, 'twou'd then be no more than 31 feet in
“ height. The atmoſphere, therefore, in its free ſtate, may be con-
“ ſider'd as if it had once been water, covering the earth, to the
“ height of 31 feet; but afterwards exceedingly rarified, expanded,
“ and converted into what we call air; tho', in fact, it poſſeſſes a
“ larger ſpace, but has not a greater weight than water of the height
“ of 31 feet. Now, 'tis exceeding eaſy to compute, what quantity of
“ water wou'd every way ſurround the earth to that height; which
“ gives the whole weight of the air. For, ſince a cubic foot of water
“ weighs 72 pounds, a priſm thereof, (to uſe that for the ſector of a
“ ſphere) whoſe baſe is a foot ſquare, and height 31 feet, will weigh
“ 2232 pounds; and ſince the ſurface of the earth contains
“ 3711.420000.000000 ſquare feet, the product of theſe two ſums,
“ which is 8.283889.440000.000000 pounds, gives the quantity of wa-
“ ter, and conſequently the quantity of air required.”

“ To render the weight of the air ſenſible, I cauſed a very light,
Fig. 4. “ glaſs bubble, AB, to be blown retort-faſhion, about the bigneſs of
“ a common ball, with the aperture B, capable only of admitting an
“ hair; and finding, by a very tender balance, its weight to be 78½
“ grains when cold; I heated it, and placed it again in the ſcale upon
“ its end B, when it ſcarce weigh'd 78 grains; then plunging its
“ orifice into water, whilſt the glaſs cool'd, and the contain'd air
“ condenſed; as much water enter'd into it, as air had been forced out
“ by the heat. Coming now to weigh the bubble again, I found it had
“ gain'd 72½ grains; whence I ſuppoſed the air expell'd by the heat,
“ was to the water that came in its place, as ½ to 72½, or as 1 to
“ 145; and tho' this cannot hence be determin'd with exactneſs, yet,

“ at leaſt, the experiment ſhews the weight of the air to be ſenſible.” M. *Paſchal.*

To find the conſiſtence of the air. Experiment 1.

A thin large bladder, wherein remained only a third of the air, ’twas capable of containing, being firmly tied at the neck, ſuſpended thereat, and fixed, by its lower end, to a fourteen pound weight that reſted on the floor, but ſo, that the ſtrings employed being well ſtretched before hand, would, if contracted even leſs than the quarter of an inch, draw up the ſame; we placed fire at ſome diſtance therefrom, by means whereof the air expanded, ſwell’d the bladder, ſhortened the whole ſtring, raiſed the weight, and made it ſwing like a pendulum. We attempted twice or thrice to repeat the experiment with a quarter of a hundred weight, and a large bladder, but did not ſucceed; the bladder either ſoon leaking or burſting; tho’ we proceeded ſo far, in one of theſe trials, as to gain hopes of thus ſuſtaining a large weight.

Experiment 2.

In order to find whether the particles of the air would ſink into a liquor expoſed to its natural preſſure, we ſtrewed copper filings over the bottom of a cylindrical vial, and poured thereon an urinous ſpirit to a conſiderable height; covering the ſurface of the liquor with oil of almonds, to the thickneſs of the fifth of an inch; when the vial was cloſe ſtopped up, and left in a quiet place for ſeveral days: during which the urinous ſpirit firſt ſlowly acquired, and then as ſlowly loſt a blue tincture. When this colour was almoſt gone, we unſtopped the vial, and kept it ſo for a minute, and then cloſed it again; when the upper part of the ſpirit began to be tinged blue, and within an hour after, tho’ the veſſel during that time was ſtopped, a ſky colour reach’d to the lower part of the fluid, and which, at preſent, is wholly blue; the oil at the top remaining clear.

The heat and coldneſs of the air.

The beſt informations, I could any ways gain, have inclined me to think, that the common ſchool-doctrine about the limits and temper of three regions in the air, however plauſible, wants a juſt foundation. A phyſician, who lately came from *Morocco*, told me, that, notwithſtanding the exceſſive heat in the day-time, the nights and the air upon the mountains, were there exceeding cold. Another gentleman, who made ſome ſtay at *Guinea*, aſſured me, tho’ the heat of the climate be prodigious, he frequently, about four a clock in the morning, was ready to ſhake with cold, in his hammock, for an hour together. A learned perſon, who lived at *Jamaica*, informed me, that, lying in his hammock, three or four feet from the ground, with many clothes underneath, but few to cover him, he felt it cold below, and hot above. ’Tis obvious, that the heat of our air in ſummer has conſiderable effects on liquors, and the fluids of animals and vegetables; but that it ſhou’d, in the ſhade, ſenſibly rarify and expand ſo compact a body as glaſs, ſeems almoſt incredible; yet this effect appears probable from glaſſes well fitted with ground ſtopples of the ſame material, which are eaſily open’d in the colder ſeaſons; but in the hot ones, I have found the ſtrength of a man inſufficient for that purpoſe; ſo that I have been frequently obliged to plunge the necks of ſuch vials in cold water, that the glaſs might ſhrink, and allow the ſtopples to be disjoin'd.

The effects of the ſummer's heat, tho' uſually attributed to the bare warmth of the air, and the agitations thereby produced in our bodies, may, perhaps, ſometimes proceed from the effluvia it excites in unregarded ſubſtances. To illuſtrate and confirm this aſſertion, I might alledge the placing of a large piece of fine amber, on a ſummer's day, when the ſun was a conſiderable height above the horizon, in the ſhaded part of a window, and there permitting it to remain for ſome time, I could find no ſigns of an attractive power therein; but upon removing it to a part of the ſame window whereto the ſun's rays had free acceſs, it preſently emitted effluvia, and readily attracted thoſe lighter bodies it would not ſtir before: but this faculty it ſoon loſt, by placing it again in the ſhaded part of the window.

The governor of *Hudſon*'s *Bay* inform'd me, that when the ſailors come within a certain diſtance of floating iſlands of ice, and the wind blows therefrom towards the ſhip, they know, by the greater degree of cold they feel, that ſuch ice lies to the windward of them; and ſometimes before 'tis viſible, or whilſt 'tis diſtant about fifteen miles from the ſhip. The wind, he obſerved, at ſuch times, uſually brings a fog along with it; which, he ſuppoſed, comes from the ice. The ſame gentleman ſaid, that where he winter'd in *Hudſon*'s *Bay*, the rivers began to freeze about the beginning of *November*, and were ſeldom free from ice till towards the latter end of *May*; tho' *Charleton Iſland*, lying at the bottom of the bay, has nearly the ſame latitude with *London*. It ſeems they are here obliged, in the winter ſeaſon, to dig ſix feet deep in ice, to come at the unfrozen water of the rivers. Brandy frequently freezes in this country; when a fourth of it is turn'd to ice, whilſt the unfrozen part remains exceeding ſtrong and fiery. The ice, which here floats on the ſea, is freſh, and ſerves, when thawed, for common water. Laſtly, my relator added, that they often find large quantities of the liquor in cavities of the floating maſſes, made by the action of the ſun thereon. A learned traveller often obſerved, during his aboad upon the *Pyrenean* mountains, that the air at the top thereof was very hot, tho' within a few hours after they would be covered with ſnow; and that too in the ſummer ſeaſon. A phyſician declared to me, that the winds he felt at *Morocco* almoſt ſtifled him, and ſeemed like ſteams coming from the mouth of an oven. The *Ruſſian* emperor's phyſician declared to me, that at *Archangel*, a northerly wind, coming from the ſea, in the winter ſeaſon, produces a thaw; but that a north-eaſt wind increaſes the froſt; and on the contrary, that a ſoutherly wind, which blows over, perhaps, a thouſand miles of frozen land, rather augments, than diminiſhes the ſame.

An inquiſitive perſon, who had alſo viſited the *Pyreneans*, declared, that both he and his company had ſometimes obſerved, from the higher parts thereof, thick clouds ſurrounding the hill, at a conſiderable diſtance below them; which produced ſtorms of rain, on the lower ground, whilſt they enjoy'd fair weather above; but when it thunder'd, they ſaw the lightning iſſue out of thoſe clouds, and ſhoot upwards, as we generally obſerve it to do downwards.

Dr. *Stubbs* informed me, that he uſually found at *Jamaica*, the water in a bolt-head, two feet and a half long, roſe in the neck, about the ſame time of the day, that is between ſeven and eight a clock in the morning, $\frac{1}{8}$ inch; the heat at that time, by reaſon of the winds, being very ſupportable; that when the ſun had paſſed the meridian, the water gradually ſubſided till the ſame time next morning; and that tho' the glaſs ſtood naked and unſtopped in a ſouth window, whereto the freſh winds had a free acceſs, the water therein did not ſenſibly decreaſe in eight or ten months time. A careful obſerver, who frequented *Sumatra*, told me, he had never found ice or ſnow, but great quantities of hail, in that torrid climate. The iſland *Ceylon* lies near the middle of the torrid *Zone*; yet one who paſſed many years upon it, aſſured me, that on hills there, where the height might be gain'd in half an hour, the temper of the air, as to heat and cold, is ſo unequal, that tho' it were vehemently hot at the bottom, he found the cold gradually increaſe as he aſcended, till it became exceſſive at the top. In the inland part of the ſame iſland, captain *Knox* inform'd me, that during the eighteen years he ſpent there, he never obſerved any ice or ſnow, only a ſmall kind of meteor betwixt dew and hoar-froſt, which ſometimes, in the winter mornings, appeared very oddly; but ſoon vaniſhed. Hail, he never ſaw there but once, and then the inhabitants were ſurprized at the novelty. It was large, as a black cherry, not very round, and ſeem'd to have its corners melted; upon biting, he found it hard and cold, like *European* hail, but it melted upon the ground, in an inſtant.

" The winter in *Suaquena* would be thought exceeding hot, but in
" ſummer, the body is then excoriated; hard *Indian* wax is melted, tho'
" locked up in cabinets, and the ſhoes of the feet are ſear'd by heat, as
" it were, with a red hot iron. The higher you aſcend up the moun-
" tains of *Æthiopia*, from the red ſea, the more temperate is the air;
" ſo that, at length, the ſummer heats are as mild here as in *Portugal*.
" Nay, there are ſome mountainous places in this country, wherein
" the cold is more violent than the heat; tho' there falls no ſnow
" in theſe parts, only a ſmall kind of hail, ſometimes, which reſem-
" bles it." *Ludol. Hiſt. Æthiop.*

The *Engliſh* conſul at *Tripoli*, in *Barbary*, inform'd me, that where the wind, in the ſummer, blows over the great ſandy deſerts there, both that and the ſand that is brought along with it, are felt as hot as the ſteams from an heated oven.

A gentleman, employed in the *French* colony, on the coaſt of *Afric*, told me, that near the iſland of St. *Louis*, when, at a certain ſeaſon of the year, the hot winds blow from the continent, the ſand on the ſhore is ſo ſcorching hot, as thro' their ſhoes to burn the feet of thoſe who ſlowly walk thereon; at which times the air ſeem'd to him hot and heavy, as if it came from an oven: and when the wind, he ſaid, blew thither from a certain wood, wherein many elephants and other wild beaſts lay dead; the air, by the effluvia of their carcaſes, became intolerably fetid.

"On the top of mount *Ida* ſtands a little chappel, made up of looſe ſtones, which, notwithſtanding the great height of the place, are, ſome of them, now and then blown down by high winds. The air in the hotteſt part of ſummer is here exceeding cold, tho' not a breath of wind be ſtirring; the hills are therefore uninhabited both winter and ſummer; for the ſhepherds lie in the vales by night, where the ſummers are violent hot, whilſt the top of the mountain is cover'd with ſnow." *Bellonius.*

"In my aſcent to the top of mount *Venus*, the air proved very clear during the whole day; but when I was got up, I ſaw clouds under me about the middle of the mountain, which intercepted my view of the valleys. Coming down in the evening, I found much rain had that day fal'n below; tho' nothing like it had happen'd above. 'twas in ſummer I went up, yet perceived no great difference in the air all the time, as to heat and cold. *Bartholin* relates the ſame of the *Alps*." *Zabarell. de region. aëris.*

A phyſician told me, he ſaw mount *Atlas* from *Morocco*, cover'd with ſnow in the heat of ſummer. And the like hath been ſeverally affirm'd to me, by travellers, of the *Alps*, where the wind has been found exceeding ſharp; of the pike of *Teneriff*, of mountains in *Barbary*, in the iſland *Ceylon*, and of *Congo*; tho' ſnow be a ſtranger to the valleys hereto adjoining.

An Experiment.

About midſummer 1688, I placed a thermometer in a cave, where the ſpirit ſtood half a ſmall diviſion above temperate; whilſt another in a common room was riſen to hot: in the chriſtmas following, the ſame glaſſes being ſet in their reſpective places, that in the cave ſtood as before, but that in the room, at froſt. The cave was cut ſtrait into the bottom of a clift, fronting the ſea, to the depth of 130 feet, with 80 feet of earth above it.

I am inform'd by two gentlemen of the province of new *Hampſhire* in *New-England*, that both the coldeſt wind of that country in the winter, and the hotteſt in the ſummer, is the north-weſt; which they aſcribed to the large tract of continent, and the large woods that lie to that point of the compaſs; for theſe woods, they ſaid, are laden with ſnow in the winter; and in ſummer, the cloſe air of the vallies, and the thick exhalations wherewith it is loaded, conceive an intenſe heat, and often breathe in a ſudden guſt like the ſuffocating ſteam of a furnace.

NAT.HIST.

“ On one ſide of the mountains of *Bavaria* 'tis winter, and on the other ſummer, at the ſame time; ſo that while this ſide is parch'd with heat, that lies buried in ſnow.” *Balbin. Hiſt. Bohem.*

A gentleman, who had frequently deſcended into the gold mines at *Cremmitz* in *Hungary*, told me, that in his aſcent out of one, which was an hundred feet deep, he obſerved the air about the middle to grow ſenſibly warm, and ſo to continue while he was drawn many feet higher; when at length it became cold again. This heat he ſuſpected might proceed from ſome mineral region thro' which he paſſed; for he there found himſelf ſurrounded by a vein of native vitriol of different colours, and ſoft in the pit, tho' it ſoon harden'd in the open air.

An experienced perſon, who had ſometimes croſſed the line, acquainted me, that the method of cooling liquors on board their ſhip, ſo as to make them potable in ſultry climates, was to wrap up the bottle wherein it was contain'd, in a coarſe linen cloth dipp'd in ſea-water, and thus expoſe it, in a proper place, to the wind; which wou'd ſoon reduce it to the ſtate deſired: but if the bottle, ſaid he, be taken away too ſoon, as it ſometimes happen'd with us, we found, ſo much of the liquor as lay near the ſides thereof grown cool, while the more central parts continued hot.

The *Czar*'s chief phyſician inform'd me, that in the year 1664, many large tracts of dry land were ſet on fire, and miſerably waſted, by the heat of the ſun. The like, in particular, he ſaid, happen'd the laſt year at *Bearhaven* in *Norway*, where ſeveral wood-houſes were alſo conſumed. This was confirm'd to him by the governor of the place; and he himſelf ſaw the country cover'd with new graſs, in the room of what was thus deſtroy'd. A learned traveller declared to me, that the inhabitants of *Mozambique*, judged the hotteſt part of the known world, had ſhewn him ſeveral houſes which were there fired by the ſole force of the ſun. Their houſes, indeed, are built with ſtone, wherein is mixed ſomething like to *Sulphur vivum*; but I my ſelf, ſays he, have often ſeen the hollows of ſtones ſo heated by the ſun, that musket bullets expoſed to its direct rays therein, were by that means alone ſoon melted. He added, that great part of the heat of *Mozambique*, is owing to the ſoil, which is exceeding bare, and conſiſts of white ſand, neither ſhaded with trees, nor cover'd with graſs. Another traveller, who had been here, aſſured me, the heat of the ground was ſo violent, that he was obliged to keep in conſtant motion, to avoid burning the ſoles of his feet.

“ Bridges of ſnow have been obſerved upon the *Pyreneans*, to reach from one rock to another, and to give paſſage to the torrents underneath them. My friend ſaw one, which thus ſerves for two ſtreams; it was 29 furlongs in length, and as much in breadth at the top. Theſe bridges ſeem ſtrong enough to allow a paſſage for canon.

" The cold was ſo exceſſive in the year 753, that it froze the *Euxine* " ſea an hundred miles in length, as well as the neighbouring ocean, " to the depth of 30 cubits; this happen'd too at the beginning of " autumn." *Journal de Savans.*

In *Guinea*, as I am inform'd by one who lived there, they keep their water cool, by burying it over-night in long earthen jars, a little below the ſurface of the earth. By this means it becomes potable, with ſome tolerable coolneſs, from early in the morning, till about ten a clock, when it grows nauſeouſly hot. But in the fields, they do this as well by letting their water hang all night in calibaſhes upon the trees; eſpecially where the wind comes at them.

" We made three degrees of cold, viz. within doors, in the woods, " and in the open air upon the ice. The latter was ſometimes into- " lerable; no cloaths were proof againſt it; no motion could reſiſt it: " twou'd freeze the hair on our eye-lids, and thereby deprive us of " ſight; and wou'd, I am perſuaded, have ſtifled a man in a very few " hours time. Our faces, or other naked part, would be daily frozen " in the woods; tho' here the cold was leſs mortifying than on the " ice. Two thirds of our houſe were cover'd, on the outſide, with " ſnow, and the inſide hung with iſicles. Our bed-cloaths would be " cover'd with an hoar-froſt, tho' they ſtood near the fire. The cook's " tubs, which were within a yard of the fire, and all day long ſup- " plied with melted ſnow, wou'd, while he ſlept but a ſingle watch, " be ſtrongly frozen to the very bottoms; he was therefore obliged " to water his meat in a braſs kettle, placed cloſe by the fire, where " I have often found the ſide of the veſſel oppoſite thereto very " warm, whilſt the other was frozen an inch deep. The ſurgeon's " ſyrups, &c. notwithſtanding his utmoſt care to preſerve them, were " all frozen; and our vinegar, oil, and ſack, that ſtood in the houſe, " ſhared the ſame fate. Both the ſea and ground continued froze till " *June*." Captain *James*.

A gentleman, who aſcended the higheſt of the *Pyreneans*, call'd *Pic de Midi*, about the beginning of *September*, when the north ſide thereof was cover'd with ſnow, told me, that both he and his companions found the air very temperate on that part of the top where the ſun did not come; but where that had free acceſs, 'twas exceeding hot, and became offenſive thro' a tent of oil'd-cloth, which they pitch'd there. Sometimes, alſo, they felt a cool wind on the top, but a much colder at the bottom. This hill may be ſeen from *Montauban*, that is, 27 leagues.

A phyſician aſſured me, that at *Morocco* he found ſome roſin of jalap, which he carried thither from *England*, melted by the heat of the air; and that it continued impulverable whilſt he remain'd in that country; but that upon returning to *Tangier*, it became pulverable again.

From the *Relatione della Provincia di Malavar*. " Summer and Winter " ſeem to meet in cape *Comorino*. Towards night, at any diſtance from

“ the cape either way, the weather and ſeaſons are found very different, and even contrary: ſo that a perſon ſailing on this ſide from *October* to *April*, has ſummer; and cannot in all that time double the cape, by reaſon he there meets the winter. This the good father who officiates in the churches of the cape finds by experience; and yet the diſtance between ’em is not above 2 or 3 miles.”

An eminent virtuoſo, who, at *Tirol*, deſcended into a mine 1800 feet deep, declared to me, that he did not find he paſſed thro’ one hot region all the way; that at the bottom he breathed very freely, by means of the air-ſhafts; and that the air there was very temperate as to heat and cold, tho’ it was now the ſummer ſeaſon. Another perſon well verſed in mines, acquainted me, that the deepeſt he had been in, was a tin one of about 400 feet; which in the ſummer ſeaſon he found very cold at the bottom, and the greateſt part of the way down, without paſſing thro’ any hot region; that the cold became perceptible within two fathom of the pit’s mouth as he deſcended; and that both in this and many other mines, he had found a ſenſible coldneſs, before he was got a yard below that ſolid earth, whereto the roots of vegetables ſeldom reach.

From a particular relation of ſeveral merchants, who together aſcended the pike of *Teneriff*, we learn, that in their ſecond days journey, when they were aſcended about a mile, they found it exceſſive hot; till they arrived at the foot of the pike, where it was wonderfully cold, tho’ in the month of *Auguſt*; eſpecially after ſun-ſet, when it began to blow violently. In their paſſage from hence to the top they found no conſiderable alteration in the air, and very little wind; but being arrived there, the wind was very impetuous. Mr. *Sydenham* told me, that aſcending the pike of *Teneriff* on the ſouth ſide, he found no ſnow, tho’ on the north ſide there was much; that on the upper part he felt no wind; and that it was violently cold at the top.

Queries for Ruſſia.

To what depth will the ground and water freeze in hard winters?

Is the ice of *Muſcovy* conſiderably harder than that of *England?*

Will water ſpirted into the air, freeze before it falls to the ground?

Will brandy, ſack, *&c.* freeze in *Ruſſia?* Or are the inſtruments made of iron and ſteel, much more brittle there than here?

How ſtands it as to the cracking of the timber in wooden houſes? And what are the cauſes thereof?

How may fleſh, fiſh, herbs, eggs, *&c.* be preſerved in hard weather?

How are thoſe to be cured, who have any part of their body frozen?

What are the ſymptoms of being froze to death?

The air conſider’d with regard to light.

A learned traveller aſſured me, that from an elevated place on the coaſt of *Genoa*, he had frequently, both morning and evening, diſcern’d the iſland *Corſica*; but cou’d never gain ſight thereof when the ſun was near the meridian, let the air be ever ſo clear.

King *Charles* II. did me the honour to acquaint me, that he once, from the beach near *Dover*, diſcover'd a new and uneven coaſt, in the edge of the horizon, on the other ſide the ſea; whereat his majeſty, as well as the duke of *York*, and the courtiers preſent, were ſurpriz'd; but having gazed a while thereon, it gradually diſappear'd, as if it had ſunk into the ocean, whence it ſeem'd to have ſprung. This phenomenon I accounted for to his majeſty, from ſubterraneous ſteams in the air, interpoſing between the coaſt of *France* and *Dover*, and cauſing an extraordinary refraction in the air; by means whereof the *French* coaſt was elevated to the eye, and ſo continued while that refraction laſted; but when the vapours were either raiſed too high, diſſipated by the ſun, or diſperſed by the winds, the refraction ceaſed, and the object became inviſible. This hypotheſis I illuſtrated by the familiar experiment of a guinea and a baſon of water; for that, or any other proper object, placed in the bottom of an empty baſon, and render'd inviſible by the interpoſition of the edge of the veſſel, between that and the eye; if water be poured into the veſſel, the guinea will then be raiſed to ſight, tho' the eye remain unmov'd. The duke of *York* was alſo pleaſed to ſay, that being near the borders of *Scotland* one morning, in dull weather, and ſeeing the ſky very red, he foretold a rainy day; but ſome of the *Scotch* nobility hence obſerved to his highneſs, that ſuch a phenomenon in that country promiſed a fair one; and the event confirm'd it. And this obſervation, as I am inform'd by a nobleman of *Scotland*, commonly holds true, under due limitation; for that tho' when the redneſs appears near the ground, with narrow ſtreaks of that colour in an intenſe degree, it ſignifies bad weather; yet if the morning bluſh be elevated in the ſky, and the wind ſit eaſterly, the day proves, generally, fair.

“ I made ſome obſervations upon the riſing and ſetting of the ſun, by means of very exact running glaſſes; for our clock and watch were both ſo frozen, tho' conſtantly kept wrapt up in cloaths, and placed in a cheſt, by the fire-ſide, that they wou'd not move. I compared my obſervations made by theſe glaſſes, with the ſtars coming to the meridian; and thus found the ſun roſe 20 minutes too ſoon, and ſet as much too late; which proceeded from the refraction of the air.

“ One evening in *March*, the moon roſe, in a very long oval, along the horizon. The weather continued extreme to the 15*th* of *April*, when our ſpring was frozen harder than it had been before in that year. When the ſun ſhone with the greateſt purity of air imaginable, we cou'd not gain ſight of a ſmall iſland four leagues diſtant from us; but when the weather proved miſty, 'twas frequently viſible, even from the loweſt ground. I took its height inſtrumentally from the ſea-ſide, and found it 34 minutes, when the ſun was elevated 28 degrees. This ſhews how great a refraction here is; by means whereof I have found the land raiſed to the ſight, tho'

“ the ſun had riſen perfectly round. *January* 6. I obſerved the lati-
“ tude exactly, when the weather was very clear, and found it 51°, 52.
“ This difference proceeded from a great refraction. *Jan.* 21. The ſun
“ roſe in an oval figure along the horizon. Others ſaw it beſides my
“ ſelf, and we all agreed 'twas twice as long as broad; but as it gra-
“ dually mounted higher, we found it recover its roundneſs. Capt. *James.*

“ In *Poland*, near *Warſaw*, at the beginning of *June* 1670, we had very
“ clear, but extremely cold weather; and for two days together obſerved
“ the ſun and two *Parhelia*, from about ten to twelve a clock; the air
“ being perfectly ſerene, and icy ſpangles viſible therein, like atoms in a
“ ſun beam. And as in common froſty weather, any ſmooth metalline
“ inſtruments, brought from the open air into a warm room, will
“ exhibit firſt a dulneſs, and then drops of water; ſo at this time
“ there would immediately appear thereon ſomething reſembling an
“ hoar-froſt. Returning from *Warſaw* in the ſame month, I ſaw in a
“ clear horizon, the ſun riſe with a large pillar over it, coloured like
“ the rain-bow; and I remember M. *Hevelius* told me, he once obſerved
“ it to ſet in the ſame manner.”[*]

A chymiſt, who paſſed the *Alps* with a gentleman of my acquaintance, informed me, that being there at the top of a forked mountain, they obſerved the valley between it almoſt cover'd with a thick thunder cloud, whilſt the weather on both the tops continued fair; and in that cloud the lightning, which ſeem'd to lie deep, and ſhone quite thro' it, like a ſhining fiſh moving ſwiftly backwards and forwards in muddy water. I my ſelf, indeed, remember, that paſſing the *Alps*, at a lower part than that juſt mention'd, tho' the weather was fair, and the ſky at the top of our mountain clear, yet we ſaw dark clouds far below us, thro' part whereof we afterwards deſcended; when they ſeem'd to differ little from a thick fog; and after we had paſſed them, we found the weather fair at the bottom.

A curious nobleman, who had long reſided at *Naples*, aſſured me, that after many fruitleſs attempts to ſee the famous apparitions in the *Sicilian* ſtreight, he at length, early in the morning, thought he perceived two ſteeples in a neighbouring town, where he knew there was but one. And taking the opportunity of the next fair morning to renew his proſpect; he was ſurprized to find a new town beyond that, where he before had ſeen two ſteeples, immenſly greater than the known one; and furniſh'd with walls, towers, churches, *&c.* This was alſo beheld, with ſurprize, by a phyſician who was with him. The colours, however, were, he ſaid, nothing near ſo lively as the figures; being chiefly dim, and intermix'd with red. Nor did the ſpectacle continue long ; for when the ſun's rays became more direct and ſtrong, they ſoon confounded this airy phantom, or mock-city.

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[*] Mr. *Lowthorp* firſt contrived an apparatus ſenſibly to demonſtrate the refraction of the air; which till then had only been perceiv'd by the nice diviſions of aſtronomical inſtruments. See *Philoſ. Tranſ.* N°. 257. And Mr *Hauksbee* afterwards, by the direction of Dr. *Halley*, made an inſtrument to determine this matter with more certainty. See *Hauksb.* Experim. p. 225—230.

“ Moiſt vapours are not the only cauſe or ſign of the air's opacity ; “ for that dry blighting eaſt-wind, call'd by the husbandmen a red “ wind, renders it at a diſtance thick and bluiſh. This is the wind “ which for the two laſt years has proved ſo pernicious to all ſorts of “ trees, as not only to blaſt the fruit, but the very leaves thereof in “ the tender.” That the air is ſometimes clear and tranſparent, and at others darken'd and clogg'd by terreſtrial ſteams, need not be ſaid ; but there are other phenomena of that fluid, depending upon its denſity, tranſparency, *&c.* which paſs unobſerved by the vulgar, and require skill in the doctrine of refraction to underſtand ; on which, therefore, I ſhall not now inſiſt. There are alſo others no leſs worthy of our notice. By comparing the different accounts of eminent authors, as to the number of the fixt ſtars, with ſome obſervations of my own ; I was induced to ſuſpect the ſeveral conſtitutions of the air might occaſion ſome variations herein. And, upon enquiry, I learnt, that celeſtial obſervations are moſt ſucceſsfully made, where the air is pureſt ; but particularly, I ſuſpected, that intenſe cold, by precipitating the vapours of the air, wou'd render it fit for this purpoſe. To confirm this conjecture, an ingenious phyſician told me, that travelling one night in *Ruſſia*, whilſt the weather was exceſſive cold, both he and his fellow-travellers ſtopp'd, to contemplate the unuſual brightneſs, and immenſe number of the ſtars, beyond what they had ever till then beheld.

“ *Charlton Iſland, January* 30 and 31. In the beginning of the night, “ there appear'd more ſtars by two thirds than ever I ſaw before. “ The cloud in cancer was full of ſmall ſtars ; and a great many ap“ pear'd among the *Pleiades*. About ten a clock the moon roſe, when “ a quarter of them became inviſible. The wind, for the greateſt “ part of this month, has ſtood northerly, and blown very cold.” Captain *James*.

The *Ruſſian* emperor's phyſician aſſured me, that one night, when 'twas prodigiouſly cold and clear, he obſerved more ſtars than ever he had ſeen in *England*, or the neighbouring parts of *Europe* ; particularly ſeveral about the *Pleiades*, and abundance of new ones in other parts of the sky ; and that they appear'd by far more bright and beautiful than uſual. Thoſe who travell'd with him, he ſaid, alſo made the ſame obſervation.

“ On the 29th of *November*, paſt 11 at night, I ſaw a light in the “ north-eaſt, along the horizon, like the day break ; when looking due “ north, I beheld ſeveral ſtreaks of light, reſembling the tail of a “ blazing ſtar, that all pointed north and ſouth ; one whereof was “ longer than what we ſaw the laſt year, for it reach'd from the “ horizon to the zenith ; paſſing between *Charles*'s wain, and the north “ ſtar. The ſmall ones ſometimes diſappear'd, and others of the

“ ſame magnitude appeared in their places, but all near the great one; two of them ſeemed to come from the two guards in *Charles*'s wain, and when theſe vaniſhed, others aroſe more to the ſouth. This light extended from W. N. W. to E. N. E. About the time of the laſt new moon ſuch another phenomenon was ſeen by the lord *Belcarus*, as he came, by night, from St. *Andrews*; by the ſailors of the yatch at *Leith*, and by ſome perſons in this town. And tho' the ſky was not then clear, yet it gave a light ſufficient to read by. It began, they told me, about ſeven, and continued till nine. Theſe phenomena are ſurprizing to us who are ſtrangers here, but the natives ſay, they frequently happen.” * This account came from his royal highneſs the duke of *York*, then high commiſſioner in *Scotland*.

The effects of the air on ſeveral bodies.

The generality of men are ſo accuſtomed to judge of things by their ſenſes, that becauſe the air is inviſible, they aſcribe but little to it, and think it but one remove from nothing. And this fluid is even by the ſchool-men, conſider'd only as a receptacle of viſible bodies, without exerting any action upon them, unleſs by its manifeſt qualities, heat and moiſture; tho' for my part, I allow it other faculties, and among them, ſuch as are generative, maturative, and corruptive; and that too in reſpect not only of animals and bodies of a light texture, but even of ſalts and minerals. An intelligent perſon, who had often ſailed from *Europe* to the *Eaſt-indies*, told me, they included their thick *Cheſhire* cheeſes in proper leaden boxes, and by that means preſerv'd them ſound, during the whole voyage; but that when ſuch a method was not made uſe of, upon cutting one near the equinoctial, the greateſt part of it would be very dry, brittle, and ſeem ſpoiled, while the central parts remain'd fat and ſoft; as if the moiſture of the whole cheeſe had retir'd thither: for if the ſame thing were done when they were come from the torrid into the temperate zone, the external portion would be good, and the cheeſe return to an uniform conſiſtence.

“ *Query*. Are not the moiſt particles, which float in the air, the cauſe of all corruption in bodies; ſince according to *Acoſta*, every thing in *Peru*, (and the ſame is obſerved of *Egypt*) where it ſeldom rains, continues long uncorrupted? or is this reſiſtance of putrefaction rather owing to the nitrous ſalt wherewith the air of thoſe countries abounds? ”

A man of learning, who had often croſſed the line, in *Portugueze* ſhips, told me, that upon their near approach thereto; he obſerved a great change in the conſiſtence of their bisket, and that moſt of their proviſion, and even their ſalt-fiſh, was ſo damaged thereby, as to be ſcarce edible. He added, that their pilot, who had been above twenty ſeveral times in the *Indies*, aſſured him, their freſh water was never thick or fetid under the equinoctial; but always as if newly put into the cask.

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* The like phenomena have of late been frequently obſerved in ſeveral other parts of *Europe*; and particular accounts are given of them in the *Philoſophical Tranſactions* and the *French Memoirs*. Mr. *Whiſton* alſo publiſhed a ſmall treatiſe upon that remarkable *Aurora Borealis*, which appeared *March* 6. 1715-6. But the phyſical cauſe of theſe lights has hitherto been only gueſſed at. See *Philoſ. Tranſact.* N°. 310, 347, 376, *&c.*

Dr. *Stubbs* aſſured me, that the ſilks brought to *Jamaica*, will, if there expoſed to the air, rot even whilſt they preſerve their colour; but if kept therefrom, hold both their ſtrength and die.

An experiment. Upon opening a ſmall glaſs receiver, wherein half a lemmon and a mercurial gage had been included for above three years, we found the fruit had preſerved both its form and colour; the upper part of the pulp was, indeed, depreſſed, and ſeemed to be dried, but the juice there wanting, appeared upon the glaſs-plate, whereto the receiver was ground and fitted; which being ſeparated, a large quantity of external air ruſh'd impetuouſly into the receiver. Neither the lemmon, nor its loſt juice, had acquired any ill ſcent, or the leaſt ſigns of putrefaction or mouldineſs; whence I conjecture, as mould appears thro' a microſcope, to be a vegetable, it requires the aſſiſtance of the air to its production. The juice was clear and without feces, in colour between brown and reddiſh; its taſte was acid, and it turned the ſyrup of violets purpliſh, and immediately corroded ſmall pieces of coral without the aſſiſtance of heat.

A ſcholar told me, that as he ſeveral times ſailed near the line, he found ſome lozenges, which he uſually carried in his pocket, quite diſſolved; tho' they never loſt their conſiſtence in any other part, nor continued fluid when he was got a few degrees beyond the equator.

A gentleman of *Sweden*, who dealt in the metals of that country, inform'd me, 'twas the practice, in the principal copper mines they had, to make uſe not of iron chains, as in other mines, to draw up their oar with, but to faſten their baskets to ropes, prepared of ox-hides; becauſe the links of iron, they found, were very ſubject to break, when loaded in hard winter weather. The maſter of a glaſs-houſe informed me, that well neal'd glaſs-metal would, ſometimes, break of it ſelf, with violence, long after 'twas made; and that, in particular, having, once ſet by a large parcel of glaſſes, for half a year, he found, at the end of that time, a fourth part of them ſpontaneouſly broken; the cracks generally proceeding from ſome of the ſalt not ſufficiently comminuted, which appeared like ſmall ſtones therein. And a learned gentleman, the owner of an iron mine, informed me, that at his houſe in *Suffolk*, which ſtands within ſix miles of the ſea, and has been built but 80 years, the iron bars of the windows, looking ſouthward to the ſalt-water, are ſo ſwelled, rotten, and brittle, as to be eaſily pulverable. He farther ſaid, that ſeveral iron bars of his, lying near the ſea-ſhore, were accidentally drench'd, for ſome hours, in the ſalt-water; whence they eaſily yielded thick flakes of ruſt when they came to be hammered.

An experienc'd maſon told me, that *Salisbury* cathedral is built of *Purbeck* ſtone, which gradually becomes ſofter, and moulders away in the air; that the ſame is obſerved of ſome *Blechington* ſtone, tho' kept from the wet; but that what comes from *Painſwick*, within four miles of *Gloceſter*, tho' ſoft and friable at the firſt, will, by lying in the air, acquire an hard, yellowiſh, glaſſy cruſt, like marble; which grows the faſter for being often waſh'd, but reaches very little below the external ſurface.

Air conſider'd with regard to flame.

I am informed, that candles will, ſometimes, continue burning in grooves, unfurniſhed with air-ſhafts, at the depth of ten fathom; but that when they come into cloſe ground, the duſt, raiſed by the workmen, (eſpecially if the ſtone be full of mundic) will extinguiſh them, unleſs freſh air be convey'd into the pit.

Experiments to be made.

To burn candles, ſpirit of wine, match, touch-wood, ſpunk, &c. under a glaſs bell; and to keep animals therein, whilſt the flame continues. To burn bodies to aſhes, in ſealed glaſſes. To do the ſame in cloſe receivers. To burn cotton in a ſealed glaſs. To make a mixture of flames, under water, in an exhauſted receiver. To burn ſpirit of wine, and oil of tupentine, in glaſs veſſels with ſlender necks. To make experiments by burning of gun-powder; and by trying to fire a piſtol in an exhauſted receiver. To burn ſaline ſubſtances in an exhauſted receiver. To burn mixtures made with ſalt-peter in exhauſted receivers. *

An experiment to ſhew the effect of air in fermentation.

Having put a ſmall handful of raiſins into a bolt-head, half fill'd with water, we exhauſted the air therefrom, and placed the containing receiver in a digeſting furnace, to forward the fermentation; the ſeaſon being then cold. After a while the raiſins emerged and floated, for ſome days, on the top of the water, when moſt of them appeared ſurrounded with numerous bubbles, and but very few of them ſubſided; tho' the number of bubbles afterwards decreaſed daily, and a ſediment appeared at the bottom of the glaſs. In a fortnight after this experiment was began, the upper part of the glaſs being accidentally broke, while I ſtood by it, the external air ruſh'd violently thereinto; and I perceived the ſurface of the liquor overſpread with bubbles, reſembling the froth of bottled beer. There alſo ſeemed to iſſue from the broken apex, a viſible fume of a languid ſcent. The liquor was highly tinged with the raiſins, and ſeemed to have gained a thicker conſiſtence than that of water.

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* It appears from ſome experiments made by Mr. *Hauksbee*, that the air paſſed thro' red hot metals or charcoal, and reſpired by animals, is ſudden death; and that it inſtantly extinguiſhes the flame of a candle; tho' the air, by this management, loſes nothing of its ſpring or ſpecific gravity; but if paſſed thro' a red-hot glaſs-tube, or metals, with no greater heat than that of boiling water, it ſeems to have no ſuch pernicious effect. *Hauksbee*'s Experim. p. 282—288.

Up-

The operation the air on odours and ſtes of bodies. xperiment 1.

Upon opening an exhauſted receiver, wherein a large quantity of verjuice with green, ſour grapes, had lain included for three years, there appeared no mouldineſs any where; only the ſurfaces of the uppermoſt skins were a little diſcoloured with ſomething, which by its taſte, and appearance, thro' a microſcope, I ſuſpected to be a kind of tartar. The liquor they had afforded was acid upon the tongue, and would diſſolve coral without heat; but the skins had a muſty ſcent. The mercurial gage ſhut up along with the verjuice, ſhew'd ſcarce any air to have been produced therein, during all this time.

The lord *Sandwich*, and two gentlemen of his retinue, aſſured me, that the common report as to their having no neceſſary houſes at *Madrid* was true; and that tho' they always make a jakes of their ſtreets over night, 'tis not eaſily diſcoverable by the ſcent the next morning. *Madrid*, however, his lordſhip ſaid, had a more offenſive ſcent than any city he knew; but they all three agreed, that the place wherein the ambaſſador's family conſtantly made water, had no ſcent of urine, and that they frequently obſerved both the dogs and cats, which lay dead in the ſtreets, afforded no offenſive ſmell.

periment 2.

Upon opening another exhauſted receiver, wherein, for above three years, ſome large pieces of oranges had been included, we found their rind changed almoſt black, ſcarce any liquor afforded, no putrid ſcent, nor the leaſt mouldineſs upon any of them.

I learnt from Mr. *Nickſon*, that they preſerved beef without ſalting it, during all the time the froſt laſted, that is, the whole winter; but that when once thoroughly frozen, 'twou'd never, tho' well dreſs'd, have its natural reliſh.

Upon their [illegible] *and ture.*

A learned man acquainted me, that he found the air of *Braſil* had a great influence upon the colours of cloaths, and even upon black; ſo that the ſable taffaty, which is there worn by the higher rank, will, in a few days, become of an iron colour; tho' when kept cloſe in the ſhops, it preſerves its proper hue. He alſo informed me, that at a place 50 leagues beyond *Parigna*, white people ſoon grow tawny; and as ſoon recover their native colour, by removing out of that quarter. The ſame gentleman further ſaid, that upon *Charlton Iſland*, there are birds reſembling our wild pigeons, but called by the *Engliſh* partridges; which appear white in winter, and grey in ſummer. The phyſician to the governor of *Jamaica* told me, that *Lignum vitæ*, and moſt other trees in that country, when freſh cut down, wou'd ſoon grow green on the new made ſurface, if that were expoſed to the air, while the parts immediately below it remain yellow; and that *Guaiacum* is ſoft whilſt growing, but when fell'd acquires ſuch a hardneſs in the air, that an ordinary tool will not touch it. Several other trees, he ſaid, had there the ſame property; but particularly the cabbage tree; the pith whereof will ſoon rot of it ſelf, and leave a large, hollow pipe, perhaps an hundred feet in length; which, inſtead of corrupting, grows almoſt as hard as iron, in the ground. A curious traveller informed me, that having gathered ſome of the aloes plant, which grows plentifully in the iſland of St. *Jago*, the juice whereof is not only exceeding glutinous and bitter, but of a very dark colour, and carried it towards the equinoctial, he there found the juice loſt its bitterneſs for a ſeaſon, and became green.

Stains cauſed by vegetable juices, are beſt taken out of linen at that time, when the ſeveral plants which afford them are in their prime. This one lady has experienced in new linen ſtain'd by the juice of quinces; and another in ſome diſcolour'd by the juice of hopps, which ſhe thinks makes the worſt of ſtains; but having long tried in vain to fetch this out, ſhe lock'd up the linen in a cheſt till the ſeaſon of hopps came on, when the ſpots thereof vaniſhed of themſelves.

Experiment 1. Having mixed one part of *Lapis Calaminaris* in powder, with four parts of fine ſalt-peter, we kept them for ſome hours in a ſtrong crucible and a vehement fire, till the ſtone was prepared; whereon we afterwards poured a proper quantity of fair water, which afforded an untranſparent ſolution of a deep red colour. This we put up into a wide mouth'd glaſs, and ſuffer'd it to ſtand in a ſouth window expoſed to the open air; where, in a ſhort time, it became quite green, and leſs turbid than before; and continuing here for ſome days longer, its green colour vaniſh'd by degrees, and the liquor appear'd tranſparent; letting fall to the bottom a red powder like brickduſt. The ſame changes happen'd in more than one parcel of this ſolution.

Experiment 2. Upon boiling ſtrong ſpirit of vinegar for a while with crude filings of copper, 'twas not apparently coloured thereby; nor even after it had ſtood for ſome hours in the glaſs egg wherein it was boil'd; we therefore poured them both together into a broad flat glaſs, and ſet it ſhelving in a window, that only one part of the filings might lie buried in the menſtruum. So much of the metal as was thus immediately expoſed to the air, became of a greeniſh blue; whilſt that cover'd by the liquor, held its own colour, till by gradually evaporating the menſtruum, it came to touch the open air, upon which it acquired the ſame colour with the former.

Experiment 3. We put one parcel of copper filings into a flat, ſhallow, wide-mouth'd glaſs, and another into a common vial; then pouring upon each a proper quantity of ſal-armoniac diſſolved in fair water, we let the veſſels ſtand together, uncover'd, for a conſiderable time; at the end whereof we found, as we expected, the liquor in the cloſer glaſs faintly tinged, while that in the more open one, was very deeply coloured. 'Twas remarkable here, that tho' the lower part of the ſolution appear'd of a deep, ultramarine blue; the upper ſurface was cover'd with a film, like thin ice, which in colour reſembled a fine turquoiſe.

Experiment 4. Two ſmall parcels of copper filings being laid upon paper coffins, we added to each of them three drops of ſpirit of ſal-armoniac; then leaving one of them in a window, we placed the other in a receiver, which was immediately afterwards exhauſted by the air-pump. Two minutes had not paſſed from the dropping on of the ſpirit, before a manifeſt blue appear'd on ſome parts of the paper left in the window; but that in the exhauſted receiver continued colourleſs for a full quarter of an hour; when, taking off the glaſs, and removing this paper to the other, in about two minutes, it diſcovered a blueneſs, which, in two more, grew conſiderably deep.

Experiment 5. By dropping ſome copper filings into a ſlender vial, containing a proper quantity of the urinous ſpirit of wine lees, whoſe colour is yellow, and ſtopping up the glaſs, we gain'd a tincture manifeſtly green; then ſuffering the glaſs to ſtand for ſeveral days in a window, we found the liquor ſlowly return to a yellow, and at length to loſe all its green colour; when, upon opening it to admit the air, and ſtopping it again, the ſurface of the liquor began immediately to change green; and this colour gradually ſpread downwards, till the whole was tinged: but by long ſtanding, it gradually alter'd to a pale yellow. Having preſerved ſeveral vials full of this liquor, I perceiv'd one of them, which had once loſt its colour, regain'd a fair blue by ſtanding, tho' the including glaſs remain'd conſtantly ſtopped; and tho' the liquor in the vial that ſtood next it, which was the ſame ſpirit impregnated with filings taken from the very ſame parcel, continued colourleſs. This glaſs, indeed, was only ſtopp'd with a cork, but I obſerved the ſame phenomenon in a bottle with a glaſs ſtopple: nay, I afterwards found it ſo in another, whilſt in one ſtopp'd with a cork, that ſtood by it, no colour appear'd. Theſe glaſſes were all fill'd with the ſame materials, and on the ſame day with thoſe abovementioned; and at the time of this obſervation, made in *Auguſt*, the weather was colder than uſual. Looking alſo, about this time, upon ſome ſpirit of amber, which had for ſeveral days ſtood upon copper filings, the glaſs being ſometimes unſtopped to admit the air, I found it had gained a green colour, tho' it before obſtinately preſerved its own.

Experiment 6. A ſlender vial filled with ſpirit of honey, tho' ſubject immediately to exchange its yellow colour for a blue, by receiving the air upon its ſurface; yet being once open'd in the place where it uſed to exhibit this phenomenon, it remain'd of a tranſparent yellow, for an hour before it turn'd blue.

Experiment 7. I have obſerved a certain liquor frequently loſt and regain'd its colour, appearing ſometimes of a faint, ſometimes of a deep blue, and ſometimes colourleſs; whilſt the fluid in another vial that ſtood near the former, wou'd ſometimes correſpond therewith, and at others vary from it. The weather ſeem'd not to be the cauſe of this variation, for the liquors wou'd both acquire and loſe colour indifferently on cold days or hot.

Obſervations. A gentleman of my acquaintance told me, that in a large piece of ground in *Wales*, near a mountain famed for the thing, he ſaw abundance of hard ſtones like flints, ſome of a dark colour, and others grey, which when newly turn'd up in tilling, appear'd of a ruſt colour, but afterwards grew gradually whiter; ſo that in three years time he found almoſt the whole parcel turn'd white. He added, what the inhabitants of the place aſſured him, that almoſt all the ſtones which lay in the neighbouring mountain expoſed to the air, underwent the ſame kind of changes, and were, in a few years, blanched.

" Some *Mercurius dulcis* and roman vitriol lying together in the ſame " box, but wrapp'd up in different papers, for the ſpace of two and " twenty months, the former was thereby changed to a ſubſtance ſo " like antimony, that it was miſtaken for it even by perſons skill'd in " drugs; the vitriol alſo had acquired the ſame colour on its ſurface, " but it ſunk no deeper."

Experiment 8. Upon the filings of copper put into a cryſtal glaſs of a conical figure, we poured ſome ſtrong ſpirit of ſalt to the height of a finger's breadth above them; when exactly cloſing the veſſel with a glaſs ſtopple, we let it continue unmoved in a window for ſome days, till the liquor had obtain'd a high, darkiſh brown colour, loſt it again, and grew clear like common water. Then taking out the ſtopple, without ſhaking the liquor, and giving acceſs to the air, the ſurface of the liquor, in a few minutes, regain'd a darkiſh brown colour; which gradually deſcending deeper, the whole body of the liquor appear'd tinged with it in a quarter of an hour. The glaſs being again well ſtopp'd, the menſtruum in a few days loſt its tincture; which, when the ſtopple was taken out, it recovered as before. And thus it ſucceeded upon ſome other trials alſo: but afterwards keeping the glaſs for a month or two together in the ſame place, I did not find that the liquor grew clear any more.

Experiment 9. Having out of another conical glaſs, furniſhed with the ſame materials, taken out the ſtopple, after the liquor had for ſome time appeared clearer than uſual, we left it open for about half an hour; but the menſtruum acquired no colour, not even at the top. When putting the ſtopple in again, I left the glaſs cloſed for two or three hours, and afterwards found the liquor had acquired a faint colour, tending to green. Upon this I again admitted the external air, leaving the glaſs unſtopp'd for above 20 hours; but in all that time it had not regain'd its uſual dark colour; appearing only of a deep green, but neither true, nor very tranſparent.

Experiment 10. Some ſtrong ſpirit of ſalt having been kept upon copper filings, till the ſolution appear'd of a dark brown colour, we put about 3 ſpoonsful of it into a receiver, that wou'd contain ten times the quantity. This being kept *in vacuo* for about half a year, it retain'd its colour, but the veſſel being open'd, and free acceſs permitted to the air, the ſolution, in an hour's time, was turn'd into a fine tranſparent green; tho' there appeared no precipitation of any muddy ſubſtance.

Experiment 11. A convenient quantity of our ſpirit of ſalt being put upon copper filings in a conical glaſs, we obſerved that the deep, muddy colour long continued; till towards the end of *December* the liquor appeared like common water: when admitting the external air, its operation was ſcarce ſenſible for ſome time; but within 24 hours the menſtruum had acquired a faint, and moderately tranſparent green. So that this tinged liquor, as it very ſlowly loſt, ſo it ſlowly and imperfectly recover'd its colour.

Experiment 12.

Upon filings of copper, in a vial that wou'd contain 2 or 3 ounces of water, we poured ſtrong ſpirit of ſal-armoniac, made without quick-lime, to near an inch above them. This was done *Auguſt* the 20th, on *Friday* before noon; and by the following *Monday* in the afternoon, it had acquired a deep blue tincture, and loſt it again ſo far, that 'twas almoſt pale like common water. Then I unſtopp'd the vial, and in a minute or leſs, the ſurface of the liquor acquired a deep blue colour, that reach'd conſiderably downwards; the whole quantity becoming, in 4 or 5 minutes more, of the like colour: and the glaſs being preſently ſtopp'd, and left in the ſame place, appeared not at the end of nine days to have loſt its tincture; tho' now and then, within that time, it ſeem'd manifeſtly paler than when we ſtopp'd up the vial.

Leſs obvious qualities introduced into bodies by the air.

A gentleman, who reſided for a year in *Guinea*, found, as did others, alſo, of his company, the heat and moiſture of the air ſo favourable to putrefaction, that their white ſugar would, ſometimes, be full of maggots; that ſeveral drugs, plaſters, *&c.* quite loſt their virtue; and that ſome of them, eſpecially their unguents, were verminous. He ſaid farther, that in the iſland of St. *Jago*, they were obliged to expoſe their ſweetmeats to the heat of the ſun; and thereby exhale the moiſture they contracted in the night, which would otherwiſe cauſe them to putrefy.

" *Oxford*, tho' ſeated chiefly on a gravelly hill, has been found very
" diſagreeable to ſome hypochondriacal and valetudinary perſons,
" eſpecially in the ſpring; I, therefore, ſuppoſe the air of that place
" to be generally moiſt."

Air too dry, tho' ſufficiently hot, is unfavourable to the production of ſeveral inſects. I have obſerved in theſe two laſt dry ſprings, that no ſoft garden ſnails were to be found; and that very few fleas infeſted the houſes, for want of moiſt vapours to nouriſh them; but in wet ſummers, ſnails, fleas, gnats, *&c.* appear in abundance.

" *Antimonium diaphoreticum*, whether prepared with nitre alone, or
" an addition of tartar, will, in time, if it be expoſed to the air,
" gain a noxious quality; and upon being taken, occaſion fainting,
" vomiting, *&c.* but this effect is eaſily prevented by exhibiting the
" medicine freſh prepared; or when kept too long, by committing
" it alone to the fire for an hour or two, or if freſh nitre be added, by
" edulcorating, and a little reverberating the preparation." *Zwelfer.*

A phyſician of the college at *London* aſſured me, from his own obſervation, that *Antimonium diaphoreticum*, having been kept for ſome years, tho' in a cloſe veſſel, acquired an emetic quality. Ceruſe of antimony, tho' it ſtood in a ſtopped glaſs, he alſo found did the ſame;

fifteen grains whereof he had given for a doſe, without the leaſt inconvenience, when the preparation was freſh: but after it was ſtale, four or five grains of it would vomit.

“ If ſome *Egyptian* earth be taken up near the river, and carefully “ preſerved from wet and waſt, ’twill be found, if duly examined by “ the balance, neither to increaſe nor diminiſh its weight till the “ 17th of *June*; when it will begin to grow heavier, and continues to “ do ſo as the river fills; whence they certainly know the ſtate of the “ deluge, which, doubtleſs, proceeds from the moiſture of the air.” *Proſper Alpinus*, *Joh. Varot*, &c.

Earth, thrown on a heap, and ſuffered to lye for five or ſix years in the air, makes better pots for cloſeneſs and bearing the fire, than what has only lain one ſeaſon above ground; tho’ this be preferable to that which is newly dug; as being not ſo apt to crack in the fire, or by wet. Such bricks, alſo, as lye near the top of the kiln, in burning, are apt to fail, when they come to be expoſed to the weather.

Air, as it regards vegetation, generation, life and death.

’Tis a common obſervation, the difference there is between the two ſides of the *Pyreneans*, that which looks to *France*, and that which reaches to *Spain*; the former being verdant and flouriſhing, whilſt the other is ſcorch’d and barren. This ſeems owing to the parching winds, which are, ſometimes, blaſting, and beat upon the *Spaniſh* ſide of the mountains; whereby the other is ſkreen’d, and enjoys all the advantages of the ſoil and climate.

“ As to life and death, with the conſiderations thereto belonging, “ we have already ſpoke to them; in like manner, alſo, not only “ phyſicians, but philoſophers, have a right to diſcourſe of the cauſes “ of health and diſeaſes; for as thoſe phyſicians, who have any tincture of accuracy and elegance, derive the principles of their art “ from nature, ſo all accurate philoſophers trace nature up to phyſic.” *Ariſtot.*

The temper of the air may, univerſally, be derived from the ſubterraneous vapours and ſuperficial effluvia of the earth, variouſly tranſpoſed, blended, and compounded by the winds, and other motions; and, probably, upon the different mixtures hereof all the local qualities of that fluid depend. A phyſician acquainted me, that about three months before the laſt great plague in *London*, he was conſulted by a man, who complain’d of a ſwelling in his groin, and thereupon confidently aſſerted, that the plague would rage dreadfully, during the following ſummer, in the ſame city: his reaſon was, that having once had a peſtilential tumour, in a former great plague-ſeaſon, two other leſs violent plagues were, ſeverally, preceeded by a leſs degree of the ſame ſymptom in himſelf.

The bare local motion of the air may, in particular caſes, operate upon bodies, either by being changed into wind, modified into ſound, or diſorder’d by thunder. ’Tis evident, that according to the vehemence or ſlackneſs of the wind, and the places from whence, and to what quarter it happens to blow, various effects enſue, eſpecially in animate bodies; and this not only as it is attended by cold and heat, moiſture and dryneſs; but conſider'd as an aerial ſtream, whereby it fans the places through which it paſſes, expels the ſtagnant air, and introduces freſh; hence it, doubtleſs, may contribute to many changes in the health of animals, but more eſpecially in the tender ſort of them. I was informed, in *Languedoc*, that if thunder happens there, after the ſilk-worms had eat their fill, and began to diſpoſe themſelves to ſpin, a great part of them would be deſtroy'd.

Upon letting horſes down, a third of the way, into mines of a thouſand feet deep, one told me, ſeveral of them died; but that others ſurvived, and work'd the engines there, without any ſenſible inconvenience in reſpiration; tho' the places they moved in, were ſupplied with air, only by the groove through which they deſcended, and one moderate ſhaft.

A curious traveller, who had viſited the mines of ſeveral countries, told me, that the deepeſt he had ſeen was in *Bohemia*, ſunk about two thouſand *Engliſh* feet.

The *Engliſh* conſul at *Tripoli*, and ſome time governor of the coaſt-caſtle belonging to the *Engliſh African* company, informed me, that the air in thoſe parts was not conſtantly hurtful, but frequently became ſo, when many of his men, who were before healthy, would ſuddenly fall ſick together, eſpecially of fevers and fluxes, which uſually killed them in eight and forty hours time.

The *Ruſſian* emperor's phyſician aſſured me, that once, when the froſt was very great in their country, and the wind at north-eaſt, if that blew againſt his face in walking, he was unable to breathe; ſo great a ſtiffneſs was thereby cauſed in the organs ſerving to that purpoſe; whence he was obliged to turn his head from the wind before he could reſpire.

An obſerving perſon informed me, that when the ſhip, he ſailed in, came under the line, he perceived the lice left the bodies of the *Engliſh* that were on board, and got wholly into their heads; from whence they deſcended again, ſome time after they had paſſed the equator. Another acquaintance of mine, who frequently croſſed the line in *Portugueze* ſhips, which uſually go crowded with people to the *Eaſt-indies*, declared, that he carefully obſerved their ſwarms of lice died away upon paſſing the equinoctial; tho' that vermin grew troubleſome again ſoon after.

The duke of *York* obſerved, during his ſtay in *Scotland*, that agues, at the ſame time they were very frequent here, ſcarce appeared in that country. A *Scotch* nobleman afterwards confirm'd the ſame, eſpecially of quartan agues; adding, that 'twas once thought very ſtrange when a certain gentleman happened there to fall ſick of one; and that quartans, which are frequently brought from *England* to *Edinburgh*, are uſually cured by any conſiderable ſtay in that city.

“ The air is purify’d by deſtroying the cauſe of corruption therein; if it be too much moiſture, fire is the remedy; eſpecially when made of odoriferous plants, as laurel, myrtle, roſemary, *&c.* by which means *Hippocrates* prevented the plague at *Athens.* Noxious vapours may alſo be diſperſed herein by the blowing of high winds. Thus the plague was lately ſtopp’d at *Liſbon*, by a great ſtorm which laſted for three days together. The like alſo happen’d in *Morocco*, where the ſame diſtemper raging very ſeverely, was diſſipated by a wind that blew as hot as the ſteam of a furnace. Artificial ſtorms may be raiſed by frequently unloading great guns; but if the vapours proceed from ſtagnant waters, they ought to be drain’d off the land thro’ proper canals; or frequently renew’d, by bringing a river to paſs thorough them. Thus the great duke of *Tuſcany* has render’d the air of his city wholeſome. If dead carcaſes, by lying unburied, have infected the air, deep pits ſhould be dug to receive them; but if filth and excrements be the cauſe of the plague, as I believe it is at *Conſtantinople* and *Liſbon*, both the ſtreets and houſes muſt be well cleanſed and purified.” *Roderic. Fons.*

“ ’Tis remarkable, that tho’ the plague rages almoſt every year, round a particular place in *Gork*, where large quantities of mercury are found; yet it never reaches that place it ſelf. This has been conſtantly obſerved by very aged men, who alſo received the tradition from their anceſtors.” *Michael Majer.*

“ Quickſilver is an alexipharmic in many diſtempers; and, ’tis ſaid, even in the plague it ſelf, (ſince thoſe parts where ’tis found, remain almoſt conſtantly free from the contagion) provided no ſalts or corroſive fluids have infected that mineral, or given it a poiſonous quality.”

A very ingenious phyſician told me, he learnt upon the iſland *Ternate*, that the *Dutch* having agreed with the king, to ſell almoſt all the clove trees that grew there, in order to raiſe the value of their ſpice, ſuch a change in the temper of the air happened thereupon, as ſhew’d the exhalations of the bloſſoms, that, when dried, afford the cloves, to be very wholeſome; for ſoon after theſe fragrant trees were cut down, the whole iſland became exceeding ſickly; which my relator imputed to the corroſive and noxious ſteams of a vulcano there; the ill effects whereof were formerly prevented by the aromatic effluvia of thoſe ſpicy bloſſoms. And ſo remarkably was the conſtitution of the air alter’d, at the time he was there, that as valetudinarians, before this happen’d, uſually reſorted thither from *Batavia*, the *Dutch* had now, for ſeveral years, been obliged to ſend men, from that and other more healthy places, once in ſix months, to relieve their garriſons here, and carry back the ſick, which were generally very numerous. A phyſician lately return’d from *Tangier*, told me, that tho’ the place it ſelf be healthy, Nat. Hist. yet ſtrangers, upon their firſt arrival, were uſually feveriſh, for many weeks; eſpecially if a ſharp continued wind blew from the eaſt.

An Experiment. Including a few ſmall ants in a receiver, we found them very briſk and lively; but, upon drawing away the air from them, they preſently loſt their motion; but ſoon recover'd it upon re-admitting the air: when exhauſting the receiver again, the inſects lay, ſome upon their backs as dead; and thus we ſuffer'd them to remain for five or ſix hours; then letting the air into them, they continued in the ſame ſtate for above twenty minutes; but at length recovering, they ran nimbly about the glaſs, tho' it was now late in the night.

The manner of fiſhing for mother of pearl; from the *Relatione della provincia di Malavar.* "The barks intended for the fiſhery being equipp'd, "repair to the iſland of *Ceylon*, along the coaſts whereof, for twenty "miles in length, at the diſtance of two or three from land, and the "depth of 6, 8, or 10 fathom, are found immenſe quantities of mother "of pearl. The barks ſetting out in the morning with a land wind, "caſt anchor at their arrival; and the divers, whereof each bark "carries fifteen or twenty, begin to diſpoſe themſelves for the work. "In order to this, each ties a rope about his middle, one end whereof "is held by a perſon left in the bark; and with another rope he ties "a ſtone to his leg; care whereof is likewiſe taken by a perſon in the "bark. Laſtly, he girds a leathern budget before him, and putting "gloves on his hands, he precipitates himſelf into the ſea; the others "all the time giving him rope enough. Thus, by the weight of the "ſtone, he is ſunk readily to the bottom; where untying the ſtone, "he is at his liberty, and the ſtone is drawn up again. The diver now "begins with great care to rake up the mother of pearl he meets "withal, putting them up in his bag; and whenever he perceives "himſelf begin to want breath, pulls the rope that girds his middle, "upon which he is inſtantly drawn out; when, diſcharging himſelf of his fiſh, he ties the ſtone again to his leg, and dives again as "before. The work is very toilſome, and even dangerous; the great "depth of ſea at which the mother of pearl is found, frequently "occaſioning them to be ſuffocated."

'Tis a conſtant obſervation, that if any foreigners lie all night on ſhoar at *Johanna*, they ſeldom eſcape being ſick there, or ſoon after they depart; the diſtemper uſually proving putrid and mortal in two or three days; whilſt thoſe who remain all day long on the ſhore, provided they every night lie on board their ſhip, diſtant above a mile from the land, commonly remain healthy. This iſland abounds with the greateſt variety of vegetables imaginable; and 'tis here exceſſive hot in the day time, but cold after ſun-ſet: whence, poſſibly, many volatile parts of thoſe plants are gradually raiſed by day, and ſuddenly condenſed by night; and at that time taint the maſs of blood, being inſpired with the air. The inhabitants themſelves are very ſubject to fevers, for which they ſcarify their breaſt and abdomen in ſeveral places; tho' few recover, unleſs they break out in blotches on ſeveral parts of the body. There ſtands a hill here of a remarkable height; the top whereof is almoſt conſtantly cover'd with thick fogs or clouds, which riſe higher, or ſink down lower, as the weather alters.

Upon the coaſt of *Coromandell*, and the moſt maritime parts of the *Eaſt-Indies*, there are, notwithſtanding the heat of the climate, annual fogs ſo thick, as to occaſion thoſe of other nations, which reſide there, and the more tender part of the natives, to keep their houſes cloſe ſhut up. And at *Balaſſore*, in the bay of *Bengale*, and ſeveral other parts of that country, ſo great a corruption of the air is occaſion'd by the rains which fall there, that the ſcent of it is very offenſive to the inhabitants. This, I preſume, chiefly happens from the great number of frogs, and other reptiles that are there left after an inundation, to dry and putrefy by the violent heat of the ſun. At theſe times alſo a violent ſickneſs, being chiefly feveriſh, proves very fatal to the natives.

When the *Engliſh* ſhips return from the *Eaſt-Indies*, they uſually carry their ſick on ſhore at St. *Helens*, where they commonly recover in a few days; which in all probability is owing to a change of the air, not diet; for the ſame proviſions may be had by the diſeaſed in the ſhips.

" The ſhorteſt paſſage from *Moſul* to *Bagdad*, is thro' *Meſopotamia*; " but there lies no village in the road; and, beſides, the wind *Samiel* blows " all ſummer long, from *Moſul* to *Surat*; for which reaſon travellers are " obliged to go by water on the *Tigre*. The word *Samiel*, ſignifies a " poiſonous wind; which, perhaps, is the burning wind mentioned by " *Job*. Whoever breathes herein dies upon the ſpot; tho' ſome have " firſt been heard to ſay they burnt internally. The body, ſoon after it's " dead, becomes black all over, and the fleſh eaſily ſeparable from the " bones." *Thevenot*.

Doctor *Collins* relates, that in *Muſcovy* the horſes are very ſubject to a particular diſtemper; from which the natives uſually preſerve them by keeping goats in their ſtables; and this method the doctor himſelf was obliged to take with his own horſes.

The *Engliſh* conſul at *Smyrna* informed me, that the plague there, tho' it abates not ſo conſiderably as at *Aleppo*, towards the beginning of *July*, when the weather is exceſſive hot, yet becomes leſs mortal and infectious at that time; the cauſe of which phenomenon may, perhaps, be, that the peſtilential effluvia floating in the air, during the former part of the ſummer, muſt be of a particular magnitude, to exert their full force; ſo that the weather growing vehemently hot, thoſe particles are thereby diſſipated, leſſen'd in their bulk, and render'd leſs noxious. Thus the wieck of a candle juſt extinguiſh'd, proves very offenſive to the noſtrils, while the parts of the ſmoke it emits are groſs; but if that ſmoke be lighted, or rarified into flame, it ſends out particles of a quite different nature, and of an inoffenſive ſcent. It may be further ſaid, that the heat of the ſun, at times, acting powerfully, penetrates deeper into the earth, and agitates the lower parts thereof; opening its obſtructed paſſages, and raiſing into the air various corpuſcles, to attenuate and divide the peſtilential ones; or elſe, by mixing therewith, form new concretions of a different bulk, texture, figure, or motion; and thus render the diſeaſes they produce leſs malignant, or of a different nature from the former. If the plague ſuffers this alteration only at *Smyrna* and *Aleppo*, it may be owing to the diſpoſition of the ſoil in thoſe places to emit peſtilential particles of a determined nature, by a particular degree of heat, and diſſipable by a greater, and thence to afford peculiar exhalations able to correct the former; as 'tis annually obſerved at *Grand Cairo*, that the plague, during the heat of ſummer, ceaſes to be mortal, and grows much leſs contagious, when the *Nile* begins to overflow. This ſeems occaſion'd by nitrous, or other exhalations, plentifully afforded from the arrival of freſh water; and not from the coolneſs it occaſions; ſince the plague will rage in much colder weather than can happen in *Egypt* during the month of *July*.

The air being fluid, as well as water, and impregnated with ſalts of different kinds, 'tis not improbable, that what happens in water, impregnated with ſuch ſalts, may alſo happen in the air. Two proper quantities of different ſalts being diſſolved in hot water, they floated undiſtinguiſhably therein, and retain'd a capacity to act in conjunction upon ſeveral occaſions; yet when the liquor became cold, the ſaline particles of one kind being no longer agitated by a due degree of heat, ſhot into cryſtals; and loſing their fluidity and motion, viſibly ſeparated themſelves from the other, which ſtill continued fluid in the liquor, and capable only of acting ſeparately. Hence it ſeems probable, that coldneſs and heat may, for a time, greatly alter the qualities of the air, with regard to the bodies and health of mankind. The cleareſt inſtance I have ſeen of this obſervation, was afforded me by the following experiment.

Experiments.

Having diſſolved equal quantities of alum and nitre in the ſame parcel of fair water, we firſt evaporated a conſiderable part of the liquor, and then expoſed the remainder to the cold in an earthen veſſel; by which means the alum firſt coagulated at the bottom and ſides thereof, in a multitude of eight-ſided figures, whilſt no cryſtals of the nitre appeared. Upon further evaporating the liquor, and removing it from the fire, we gain'd more grains of alum, but yet no nitre; we, therefore, evaporated more of the water, till, at length, the nitre plentifully ſhot into its proper cryſtals.

A mouſe lived for ten minutes, with only a fourth of the natural quantity of the air, and three afterwards.*

The effect of rain; and a prognoſtic thereof.

An eminent virtuoſo informed me, that in the country of *Campen*, he ſaw ſeveral ſhallow pits dug for peat, till they came to a kind of quick-ſand, whereon the rain having faln for ſome years, had form'd a kind of clay, from whence good iron was, by skill, attainable. The ſame perſon aſſured me, he had frequently diſtilled the water of *Campen*, in fine new glaſſes, and that notwithſtanding its rectification, it always left a conſiderable quantity of ſtony matter at the bottom.

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* Dr. *Halley* tells us, 'tis found by experiment, that a gallon of air, included in a bladder, and reciprocally inſpired and expired by means of a pipe, will become unfit for farther reſpiration in little more than a minute. *Philoſ. Tranſ.* N°. 349. p. 492.

" *Milleſſow*, a mountain in *Bohemia*, prognoſticates the weather. I once " beheld this whole mountain covered with very thick clouds, whilſt " the other mountains, which ſtood around it, ſhew'd no ſigns of any, " and the ſun alſo ſhone very bright; the inhabitants, however, upon " this prepared for foul weather, and adviſed me to do the like; when " in the ſpace of a quarter of an hour, the sky grew cloudy, the ſun " withdrew his rays, and a prodigious ſhower enſued. At another time, " I found all the mountains about *Milleſſow* reek with vapours, while " *Milleſſow* it ſelf was not affected; when the inhabitants ſaid, they " apprehended no miſchief from hence, for that *Milleſſow* wou'd drink " up all thoſe clouds."

Large hail.

" At *Liſle* in *Flanders*, there fell, in the month of *May*, a ſhower of " hail, the ſmalleſt ſtones whereof were as big as pigeons eggs. The " ſtorm falling upon the citadel, and the whole town, broke all the " windows that faced the wind, laid open the tops of the houſes, tore " up the trees, ſpoiled the corn, and killed all the hares and par" tridges. Some of theſe hail-ſtones weigh'd a quarter of a pound, " ſome half a pound, others three quarters, and the largeſt ſort of all " above a pound. In the middle of ſome of them was a brown ſub" ſtance, which put into the fire made a loud noiſe therein: others " were tranſparent, and immediately melted like lead, when laid before " the fire; tho' theſe were harder than the reſt."

A ſhower of fiſh.

" In that year the duke of *York* laſt return'd from *Scotland* to *London*, " at the upper part of *Galloway* in *Scotland*, there rain'd ſuch a ſhower of " ſmall fiſhes, exactly reſembling herrings in their colour, taſt, and " form, that they cover'd two acres of land belonging to Sir *Robert* " *Murray* of *Brughton*. This I confirm'd to his royal highneſs, as having " my ſelf ſeen ſome of the fiſhes. His highneſs ingeniouſly accounted for " the phenomenon, by ſuppoſing the whole number raiſed with the " water by a whirlwind, and carried into the air; from whence they " afterwards fell by their own weight to the ground."

SUSPICIONS ABOUT SOME HIDDEN QUALITIES IN THE AIR.

SECT. I.

BESIDES heat, cold, dryneſs, moiſture, gravity, elaſticity, the power of refracting the rays of light, *&c.* I have often ſuſpected there may be ſome more latent qualities in the air, different from theſe, and principally ariſing from the ſubſtantial parts or ingredients whereof it conſiſts. For our atmoſphere is a confuſed aggregate of effluvia from ſuch different bodies, that tho' they all agree in conſtituting, by their minuteneſs and various motions, one great maſs of fluid matter, yet, perhaps, there is not a more heterogeneous body in the world.

Subterraneous effluvia in the air.

'Tis highly probable, that beſides thoſe vapours and exhalations which, by the heat of the ſun, are elevated into the air, and there afford matter for ſome meteors, as clouds, rain, parhelions, and rainbows; there are, ſometimes, at leaſt, and in ſome places, plenty of effluvia emitted from the ſubterraneal parts of the terreſtrial globe: and 'tis no leſs probable, that in the ſubterraneal regions there may be many bodies, ſome fluid, and ſome conſiſtent, which, tho' of an operative nature, and likely, upon occaſion, to emit ſteams, ſeldom or never appear upon the ſurface of the earth; ſo that ſeveral of them have not ſo much as names aſſign'd them even by mineraliſts. Now among this multitude and variety of bodies that lie buried out of ſight, who knows but there may be many of a nature very different from thoſe we are hitherto acquainted with; and that as ſeveral wonderful and peculiar operations of the load-ſtone, tho' a mineral, many ages ago famous among philoſophers and phyſicians, were not diſcover'd till of late; ſo there may be other ſubterraneous bodies, endued with conſiderable powers, which, to us, remain unknown; and would, if known, be found different from thoſe of the foſſils wherewith we are hitherto acquainted?

Celeſtial effluvia in the air.

Farther, the ſun and planets may have influences here below, diſtinct from their heat and light. And the ſubtile effluvia, even of theſe bodies, may reach our air, and mix with thoſe of our globe in that great receptacle of celeſtial and terreſtrial ſteams, the atmoſphere. The very ſmall knowledge we have of the ſtructure and conſtitution of globes ſo vaſtly remote from us, and our great ignorance of the nature of the particular bodies that may be preſum'd to be contain'd in thoſe globes, which, in many things, appear of kin to this we inhabit, leaves room to conjecture, that many of thoſe bodies, and their effluvia, may be of a nature quite different from thoſe we here take notice of*; and may, conſequently, operate after a very different and peculiar manner.

Effluvia from the operations of the air.

And tho' the chief of the heterogeneous effluvia, that endue the air with ſecret qualities, may, probably, proceed from beneath the ſurface of the earth, and from the celeſtial bodies; yet at ſome times, and in ſome places, the air may derive multitudes of efficacious particles from its own operations; acting as a fluid ſubſtance upon the vaſt number and variety of bodies, which are immediately expoſed to it. For tho', by reaſon of its great thinneſs, and of its being, in its uſual ſtate, deſtitute both of taſt and ſmell, it ſeems wholly unfit to be a menſtruum; yet it may have a diſſolving, or at leaſt a conſuming power on many bodies; eſpecially ſuch as are peculiarly diſpoſed to admit its operations. For the air has a great advantage, by the vaſt quantity of it that may come to work, in proportion to the bodies expoſed thereto. And in ſeveral caſes, the quantity of a menſtruum may much more conſiderably ſupply its want of ſtrength, than chymiſts ſeem commonly aware of. There are liquors too, which, tho' they paſs for inſipid, are not quite deſtitute of corpuſcles fit to act as a ſolvent; eſpecially if they have time enough to make, with the other parts of the fluid, ſuch numerous and various motions as muſt bring now ſome of them, and then others, to hit againſt the body expoſed to them. Thus we find a ruſt on copper, that has been long expoſed to the air; whoſe ſaline particles, in time, gradually faſten themſelves, in ſuch numbers, to the ſurface of the metal, as to corrode it, and produce a ſubſtance of the colour of verdigreaſe; which is a factitious body, made of the ſame metal, corroded by the ſharp corpuſcles of vinegar, or of the husks of grapes. And by the power which mercury has to diſſolve gold and ſilver, it appears not always neceſſary, that a fluid ſolvent ſhould affect the taſt. And as to thoſe bodies on which the aerial menſtruum can operate, its immenſe quantity may bring this advantage, that tho' even the ſtrongeſt menſtrua, if they bear no great proportion, in bulk, to the bodies they are to work on, are eaſily glutted, and being unable to take up any more, leave the reſt of the body undiſſolved; this bears ſo vaſt a proportion to the bodies expoſed to it, that when one portion of it has impregnated it ſelf as much as 'tis able, there may ſtill come freſh to operate farther on the remaining part of the body.

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* Sir *Iſaac Newton*, after his uſual manner, has on a ſolid foundation carried this thing a ſurprizing length. "The comet, ſays he, which appeared in the year 1680. was not, in its perihelion, diſtant from the ſun's body ſo much as a ſixth part of his diameter; and conſequently, by reaſon of its vaſt velocity at ſo near an approach, and the denſity of the ſun's atmoſphere, it muſt have ſuffered ſome reſiſtance and retardation, by means whereof 'twas drawn nearer to the ſun; ſo that approaching ſtill nearer in every revolution, it muſt, at length, fall into the body of him. In its aphelion, alſo, where its motion is exceeding ſlow, it may, ſometimes be retarded by the attraction of other comets, and afterwards fall into the ſun. Thus alſo the fixed ſtars, which gradually ſpend themſelves in light and vapour, may be recruited by comets falling into them; and being thus lighted up again, and having new aliment afforded them, may paſs for new ſtars. But the vapours, which ariſe from the ſun, the fixed ſtars, and the tails of comets, may, by their gravity, fall into the atmoſpheres of the planets; and there be condenſed and turned into water and moiſt ſpirits, and thence gradually, by a ſlow heat, into ſalts, ſulphurs, tinctures, mud, clay, marl, ſand, ſtones, coral, and other terreſtrial ſubſtances. But as the ſun's body decreaſes, the mean motions of the planets about the ſun will, by degrees, be retarded; and as the earth increaſes, the mean motion of the moon about the earth, will be gradually accelerated: and, indeed, Dr. *Halley*, from comparing the *Babyloniſh* obſervations of eclipſes, with thoſe of *Albategnius*, and the moderns, was the firſt, that I know of, who obſerved the mean motion of the moon, compared with the diurnal motion of the earth, to accelerate gradually." *Newton. Princip.* p. 480, 481.

But beſides, the ſaline and ſulphureous particles, that, at leaſt, in ſome places, may impregnate the air, and give it the greater affinity to proper chymical menſtrua, it may, merely as a fluid body, conſiſting of corpuſcles of different ſizes, and ſolidities reſtleſly and variouſly mov'd, be, upon account hereof, ſtill diſſolving, or preving upon the particles of the bodies ſubmitted to its action. For many of the aerial corpuſcles hitting or rubbing every minute againſt thoſe particles of bodies that chance to lie in their way, may well, by their numerous occurſions and attritions, ſtrike off and carry along with them now ſome, and then others of their particles; as it happens in water, which, tho' very ſoft and fluid, wears out ſuch hard and ſolid bodies as ſtones themſelves, if it often meet them in its paſſage. The aerial corpuſcles, indeed, are very minute, and the bodies expoſed to them often large, and ſeemingly ſolid; but 'tis not upon the whole body at once, that they endeavour to work, only on the ſuperficial particles, which may often be more minute than thoſe corpuſcles. Thus a lump of loaf-ſugar, or *Sal gemmæ*, being caſt into common water, tho' this liquor be inſipid, and the motions of its corpuſcles very languid, yet theſe corpuſcles are able to looſen and carry off the ſuperficial particles of the ſugar or ſalt that chance to lie in their way; and freſh corpuſcles of water ſtill ſucceeding, to work upon the remaining particles of the body that ſtand in their way, the whole lump is gradually diſſolv'd, and ceaſes to appear to the eye diſtinct from the liquor. And 'tis not impoſſible that ſome bodies may receive a diſpoſition to volatility; and conſequently, to paſs into the air by the action either of the ſun-beams, or of ſome ſubſtance that once iſſued out of the ſun, and reached to our air. For there may be certain bodies, generally in the form of liquors, which, tho' they paſs off from ſome peculiarly diſpos'd ſubſtances, will, during their ſtay or contact, produce in them a great and ſtrange aptneſs to be volatilized; at leaſt, 'tis agreeable to experience, that either upon the accounts abovementioned, or of ſome others, thoſe parts of the atmoſphere, which, in a ſtricter ſenſe, may be called the air, are in ſome places ſo intermixed with particles of different kinds, that among ſo great a number of various ſorts of them, 'tis very likely there ſhould be ſome kinds of an uncommon and an unobſerv'd nature; as might ſeem probable by the waſting of odorous bodies, and eſpecially camphire; and becauſe ſome ſolid bodies actually cold, when their ſuperficial parts are newly taken off, emit, tho' inviſibly, ſuch large ſteams into the air, as continually to grow manifeſtly lighter upon the balance.

The growth of ſalts in bodies expoſed to the air.

The firſt phenomenon I ſhall propoſe, to ſtrengthen theſe ſuſpicions, is, the appearance or growth of ſome ſalts, in certain bodies which afford them not at all; or nothing near in ſuch plenty, or ſo ſoon, unleſs they be expos'd to the air.

Suſpecting a ſolid marcaſite, hard as ſtone, to be fit to make an inſtance for my purpoſe, I caus'd it to be broken, that the internal and more ſhining parts might be expos'd to the air; but tho' this were done in a room where a good fire was uſually kept, ſo that the marcaſite was not only ſheltered from the rain, but kept in a dry air; yet after a while, I diſcover'd, upon the glittering parts, an efflореſcence of a vitriolic nature. And afterwards meeting with a ponderous, and dark coloured mineral, which at the firſt breaking diſcover'd to the eye no appearance of any ſalt, nor ſo much as any ſhining marcaſitical particles; we found, nevertheleſs, that a large quantity of theſe hard and heavy bodies being kept expoſed to the air, even in a room that preſerved them from the rain, tho', probably, they had lain many ages entire on the hill wherein they were found; yet in a few months, by the operation of the air upon them, they were in great part crumbled to a powder, exceeding rich in copperas. Nay, having laid up ſome of theſe ſtones in a room where I conſtantly kept a fire, and in the drawer of a cabinet, which I did not often take out to give them *freſh* air, moſt of them were covered with a large efflореſcence; which, by its conſpicuous colour, between blue and green, by its taſt and fitneſs to make in a trice an inky mixture, with an infuſion of galls, ſufficiently manifeſted it ſelf to be vitriol; the growth whereof, by the help of the contact of the air, is the more conſiderable, becauſe it is not a mere acid ſalt, but abounds in ſulphureous and combuſtible parts, NAT.HIST. which I have ſeveral times actually ſeparated, or obtain'd from common vitriol, without the addition of any combuſtible body; and ſometimes without any addition at all. It was alſo uncommon, that our blackiſh minerals required no longer time, nor any rain, to make them afford their vitriolic efloreſcencies; for I kept many of thoſe marcaſites, both glittering ones and others, of which they make great quantities of vitriol at *Deptford*, without perceiving in them a change, that came any thing near to what I have mentioned. And I have obſerved thoſe whoſe trade it is to make vitriol, are often oblig'd to let their vitriol-ſtones, as they call them, lie for half a year, nay, ſometimes two years, expoſed not only to the open air, but to the rain and ſun, before they can obtain from them their vitriolic parts.

That alſo the earth, or ore of alum, robb'd of its ſalt, will, in tract of time, recover it, by being expoſed to the air, we are aſſured by the experienced *Agricola*. I have likewiſe obſerved, that ſome kind of lime in old walls and moiſt places, has, in time, gain'd a large efloreſcence, very much of a nitrous nature; as I was convinced, by having obtain'd ſalt-petre from it, upon barely diſſolving it in common water, and evaporating the filtred ſolution: and alſo in calcined vitriol, whoſe ſaline parts have been driven away by the violence of the fire, particles of freſh ſalt may be found, after it has lain a competent time in the air.

But tho' theſe and the like obſervations have generally paſs'd, without being call'd in queſtion; yet it ſeems to me ſomewhat doubtful, whether the ſalts that appear in the forementioned caſes, are really produced by the operation of the air working as an agent, or alſo concurring as an ingredient; or whether theſe ſaline ſubſtances proceed not from ſome internal thing, analagous to a ſeminal principle, cauſing in them a kind of maturation of ſome parts; which being once ripen'd, and perhaps aſſiſted by the moiſture of the air, diſcloſe themſelves in the form of ſaline concretions; as in the feculent or tartarous part of wines, there will, in tract of time, be generated or produced, numerous corpuſcles of a ſaline nature, that give the acid taſt we find in tartar, eſpecially in that of *Rheniſh* wine. It may alſo be ſuſpected, that the ſalts found in marcaſites, in nitrous and aluminous earths, *&c.* are made by the ſaline particles of the like nature; that among multitudes of other kinds ſwim in the air, and are attracted by the ſimilar particles yet remaining in the terreſtrial bodies, which are, as it were, the wombs of ſuch minerals; as ſpirit of nitre will with fixed nitre, and ſome other alkalies, compoſe ſalt-peter; or elſe, that ſuch aerial ſalts, aſſiſted by the moiſture of the air, ſoften, open, and almoſt corrode, or diſſolve the more terreſtrial ſubſtance of theſe wombs, and thereby ſollicit and extricate the latent ſaline particles; and by their union with them, compoſe thoſe reſulting bodies that reſemble vitriol, alum, *&c.* However, if a convenient quantity of nitrous earth, or other proper ſubſtance, be kept in a cloſe veſſel, whereto the air has no acceſs, for as long a time as has been obſerv'd ſufficient to impregnate the like ſubſtance, or a portion of the ſame matter that was included, it may help to remove our ſcruples; for if the body that was kept cloſe, have either gain'd ſalt at all, or very much leſs in proportion to its bulk, than that which was kept expoſed, we may thence learn, what is to be aſcribed to the air in the production of nitre, or other ſaline concretions. And having obſerved none of theſe bodies, that would ſo ſoon, and ſo manifeſtly even to the eye, diſcloſe a ſaline ſubſtance, as the blackiſh vitriol-ore before mentioned; I judged this a very fit ſubject, wherewith to try what maturation, or time, the air being ſecluded, wou'd do in this caſe. Accordingly, having taken ſome fragments of it, which we carefully freed from the adhering vitriolic efloreſcence, we put of different ſizes of them into two conveniently ſhap'd glaſſes, which being hermetically ſealed, were order'd to be kept in fit places; by which means 'twas expected, that even, without opening the glaſſes, we ſhould be able eaſily to ſee, by the changed colour of the ſuperficial parts, whether any vitriolic efloreſcence was produced; but thro' the negligence, or miſtake, of thoſe to whom the care was recommended, the experiment was never brought to an iſſue. Tho' after ſome time I perceiv'd, that notwithſtanding the glaſs had been ſo cloſely ſtopp'd, there plainly appeared on the outſide of the maſs, ſome grains of an efloreſcence; whoſe colour, between blue and green, argued it to be of a vitriolic nature. But although, till the ſucceſs of ſome ſuch trial be known, I dare not confidently pronounce about the production or regeneration of ſalts, in bodies that have been robb'd of them, and aſcribe it wholly to the air; yet when I conſider the ſeveral great effects of the air upon ſeveral other bodies, I think it not raſh to conjecture, in the mean time, that the operations of the air may have a conſiderable ſhare in theſe phenomena; and ſo, that there may be latent qualities in the air; theſe qualities being underſtood *in concreto*, together with the ſubſtances, or corporeal effluvia, wherein they reſide. And of ſuch aerial qualities, taken in this ſenſe, I ſhall now proceed to mention ſome other inſtances.

A vital ſubſtance in the air.

The difficulty we find in keeping flame and fire alive, tho' but for a little time, without air, renders it ſuſpicious, that there may be diſperſed thro' the reſt of the atmoſphere, ſome odd ſubſtance, either of a ſolar, aſtral, or other foreign nature; on account whereof the air is ſo neceſſary to the ſubſiſtance of flame. And this neceſſity I have found to be more conſiderable, and leſs dependent upon the manifeſt attributes of the air, than is uſually obſerv'd; for by trials purpoſely made, it has appear'd, that a ſmall flame of a lamp, tho' fed perhaps with a ſubtile, thin oil, wou'd in a large glaſs-receiver expire for want of air, in a far leſs time than one wou'd believe. And it will not much leſſen the difficulty to alledge, that either the groſs fuliginous ſmoke in a cloſe veſſel ſtifled the flame, or that the preſſure of the air is requiſite to

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impel up the aliment into the wieck; for to obviate theſe objections, I have, in a large receiver, employed a very ſmall wieck, with ſuch rectified ſpirit of wine, as wou'd in the free air burn totally away; yet when a very ſmall lamp, furniſhed with ſuch a very ſlender wieck, was made to burn, and, filled with this liquor, was put lighted into a large receiver, that little flame, tho' it emitted no viſible ſmoke at all, wou'd uſually expire within about one minute, and often in leſs; and this tho' the wieck was not ſo much as ſing'd by the flame: nor indeed is a wieck neceſſary for the experiment, ſince highly rectified ſpirit of wine will, in the free air, flame away without it. And it ſeems ſurprizing, what that ſhould be in the air, which enabling it to keep flame alive, does yet, by being conſum'd or deprav'd, ſo ſuddenly render the air unfit to preſerve flame. It alſo ſeems by the ſudden waſting or ſpoiling of this fine ſubſtance, whatever it be, that the bulk of it is but very ſmall in proportion to the air it impregnates with its vertue: for after the extinction of the flame, the air in the receiver was not viſibly alter'd; and, for ought I could perceive by ſeveral ways of judging, the air retained either all, or at leaſt the far greateſt part of its elaſticity; which I take to be its moſt genuine and diſtinguiſhing property. And this undeſtroy'd ſpringyneſs of the air, with the neceſſity of freſh air to the life of hot animals, ſuggeſts a great ſuſpicion of ſome vital ſubſtance, if I may ſo call it, diffuſed thro' the air; whether it be a volatile nitre, or rather, ſome anonymous ſubſtance, ſidereal or ſubterraneal; tho' not improbably of kin to that which ſeems ſo neceſſary to the maintenance of the other flames.

By keeping putrefied bodies in glaſſes hermetically ſeal'd, and thereby ſecured from the contact of the external air, I have not been able to produce any inſect, or other living creature; tho' ſometimes I have kept animal ſubſtances, and even blood, ſo included for many months; and one or two of them for a longer time; and tho' theſe ſubſtances had a manifeſt change made in their conſiſtence, whilſt they remain'd ſeal'd up. I ſhall here add another obſervation, that I met with in a little diſſertation, *de admirandis Hungariæ aquis*, written by an *Hungarian* nobleman; where ſpeaking of the native ſalt which abounds in their regions, he ſays that "in the chief mine of *Tranſylvania*, called *Deſienſis*, there was, a few years before he wrote, a great oak, like a "huge beam, dug out of the middle of the ſalt; but tho' it was ſo "hard, that it could not eaſily be wrought upon by iron tools, yet "being expos'd to the air out of the mine, it became ſo rotten, that "in four days it was eaſy to be crumbled between the fingers." And of that corruptive, or diſſolutive power of the air near thoſe mines, the ſame author mentions other inſtances.

Seminal cor- uſcles in the ir.

Having found an antimonial preparation to prove emetic, in a caſe where I did not at all expect it; I enquired of ſome phyſicians and chymiſts of my acquaintance, whether they had not taken notice, that *Antimonium diaphoreticum* wou'd become vomitive, if 'twere not kept from the air? And more than one phyſician aſſured me, it wou'd; as they had found by particular trials. I find alſo, that the experienced *Zwelfer* gives a caution againſt letting the air come at theſe antimonial medicines; leſt it ſhould render them, as he ſays it will in tract of time, not only emetic, but diſpos'd to produce heart-burnings, faintings, and other bad ſymptoms. And I learnt from a very ingenious phyſician, that having carefully prepared *Antimonium diaphoreticum*, he gave many doſes of it whilſt it was freſh, and kept ſtopt in a glaſs, without finding that in any patient it procured one vomit; but having kept a parcel of the ſame remedy for a conſiderable time, in a glaſs, only cover'd looſely with a paper; the medicine, vitiated by the air, prov'd ſtrongly emetic to thoſe, who neither by conſtitution, nor foulneſs of ſtomach, or on any other diſcernable account, were more than others that had taken it, diſpos'd to vomit. By which obſervations, and what I before remark'd of ſalt-peter obtainable from lime, it ſhould ſeem, as if either there were in the air a ſubſtance diſpoſed to be aſſimilated by all kinds of bodies; or that the air is ſo vaſt and rich a magazine of innumerable ſeminal corpuſcles, and other analogous particles, that almoſt any body long expos'd thereto, may there meet with particles of kin to it ſelf, and fit to repair its injuries and loſſes, and reſtore it to its natural ſtate.

A lixivious property in the air.

M. *de Rochefort*, in the account he gives of the fruit of the tree *Junipa*, the juice whereof is employ'd by the *Indians* to black their skins, that they may look the more terrible to their enemies, obſerves, that tho' the ſtain or tincture of this fruit cannot be waſh'd out with ſoap; yet within nine or ten days it will vaniſh of it ſelf: which wou'd make one ſuſpect, that there may be in the air ſome ſecret, powerful ſubſtance, that renders it a menſtruum of more efficacy than ſoap it ſelf, to take away ſtains. I have ſeen this fruit, but not whilſt it was juicy enough to have a trial made with it, which I ſhould have been glad of, becauſe the author does not clearly expreſs, whether this diſappearing of the tincture happens indifferently to the bodies it chances to ſtain, or is only obſerved on the skins of men: for as in the former caſe 'twill afford an inſtance pertinent to our preſent purpoſe; ſo in the latter, I ſhould ſuſpect, that the vaniſhing of the tincture may be due, not ſo much to the operation of air upon it, as to the ſweat and exhalations of a human body; which abounding with volatile ſalt, may either deſtroy, or carry off with them, the colour'd particles they meet with in their paſſage.

A power in the air to change the texture of metals.

I have ſometimes, with wonder, obſerv'd the excellency of the better ſort of *Damaſco* ſteel, in compariſon of ordinary ſteel. And there is one phenomenon, which, tho' I am not ſure it belongs to the latent qualities of the air, yet becauſe it very well may, I will here relate it. Having enquired of an eminent and experienced artificer, whom I employ in ſome difficult experiments, about the properties of *Damaſco* ſteel; the honeſt, ſober man, averr'd to me, that when he made inſtruments of it, and gave them the true temper, which is ſomewhat different from that of other ſteel, he generally obſerved, that, tho' when razors, *&c.* made of it, were newly forg'd, they would be, ſometimes, worſe than thoſe of other ſteel; yet when they had been kept for a year, or two, or three in the air, tho' nothing elſe was done to improve them, they would much ſurpaſs other inſtruments of the ſame kind, and what themſelves were before; ſo that ſome of them have been laid aſide, at firſt, as no ways anſwering the great expectation conceived of them, which, after two or three years, they were found to exceed. And I have ſeveral times made a ſubſtance, that conſiſts chiefly of a metalline body, and is of a texture ſo cloſe as to lie for many hours undiſſolved in a corroſive menſtruum; yet this ſubſtance, that was fixed enough to endure melting by the fire, without loſing its colour, would, when I had purpoſely expoſed it to the air, be diſſolved in a very ſhort time, and have its ſuperficial parts turn'd almoſt black.

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And this brings to mind the very pretty obſervation, newly made in *Italy* by an ingenious man, who took notice, that, if after the opening of a vein, the blood be kept till it be concreted, and have excluded the ſuperficial ſerum, tho' the lower part be uſually of a dark and blackiſh colour, in compariſon of the ſuperficial parts, and therefore be counted far more feculent; yet if the lump or clot of blood be broken, and the internal and dark colour'd parts of it expoſed to the air, it will, after a time, be ſo wrought on thereby, that the new ſuperficial part will appear as florid as the the upper part ſeemed before. And this obſervation I found to hold in the blood of ſome beaſts, whereon I tried it; but I have found it to ſucceed in much fewer minutes than the *Italian* experiment, on human blood, made me expect.

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On the other ſide, I have often prepared a ſubſtance, wherein the effect appears quite contrary to this. For tho' the factitious concrete, whilſt kept to the fire, or very carefully preſerv'd from the air, be of a red colour, almoſt like the common opake bloodſtone of the ſhops, yet if I broke it, and left the lumps in the air, it would, in a ſhort time, perhaps, in leſs than a quarter of an hour, have its ſuperficial parts turned of a very dark colour, ſometimes ſcarce at all ſhort of blackneſs.

A very inquiſitive perſon, of my acquaintance, making, by diſtillation, a medicine of his own deviſing, chanc'd to obſerve this odd property in it, that if it were kept ſtopp'd, it would be coagulated almoſt like oil of aniſeed, in cold weather; yet if the ſtopple were taken out, and acceſs for a while given to the air, it would turn to a liquor, and the veſſel being again ſtopp'd, it would, tho' more ſlowly, coagulate again. And deſiring to ſee this odd preparation, I found it, when brought into the room where I was, not liquid, but conſiſtent; tho' of a ſlight and ſoft texture. And having taken out the cork, and ſet the viol in a window, tho' the ſeaſon, being winter, was cold; yet, in a little time, I found the coagulated ſubſtance almoſt become fluid. And another time, when the ſeaſon was leſs cold, being where the vial was kept well ſtopp'd, and caſting my eyes on it, I perceived the included ſubſtance to be coagulated much like oil of aniſeed. And this ſubſtance having, as the maker aſſured me, nothing at all of mineral in it, nor any chymical ſalt; but conſiſting only of two ſimple bodies, the one a vegetable, and the other an animal ſubſtance, diſtill'd together; theſe contrary effects of the air, (which ſeems to have a power, in ſome circumſtances, to coagulate ſuch a body, and yet to diſſolve and make it fluid, when freſh parts are allow'd acceſs) may deſerve to be farther reflected on, with regard to the ſeaſonable operations the inſpired air may have on the conſiſtence and motion of the circulating blood, and to the diſcharge of the fuliginous recrements to be ſeparated from it in its paſſage thro' the lungs.

There are two other phenomena which ſeem favourable to our ſuſpicion, there being anonymous ſubſtances and qualities in the air: the one is, the growth or apparent production of metals and minerals dug out of the earth, and expoſed to the air. But of this we ſhall treat more particularly hereafter; tho' the caution formerly given about the regeneration of ſalts in nitrous and other earths, may, *mutatis mutandis*, be applied to this production of metalline and mineral bodies. The other phenomenon is afforded by the various and odd contagious diſeaſes, that at ſome times, and in ſome places, invade and deſtroy numbers of beaſts, ſometimes of one particular kind, and ſometimes of another. Of this we have many inſtances in the books of approved authors, both phyſicians and others; and I have my ſelf obſerved ſome notable examples of it. Probably the ſubterraneal parts of the earth, ſometimes, eſpecially after earthquakes, ſend up into the air peculiar kinds of venomous exhalations that produce new and mortal diſeaſes, in animals of a particular ſpecies, and not in thoſe of another; and in this, or that particular place, and not elſewhere; of which we have an eminent inſtance in that odd plague, or murrain, of the year 1514; which *Fernelius* tells us, invaded none but cats. And even in animals of the ſame ſpecies, ſometimes one ſort has been incomparably more obnoxious to the plague than another. *Dionyſius Halicarnaſſeus* mentions a plague that attack'd none but maids: and the peſtilence, that raged in the time of *Gentilis*, a fam'd phyſician, kill'd but few women, and ſcarce any but luſty men. *Boterus*, alſo, mentions a great plague, that aſſaulted almoſt only the younger ſorts of perſons; few paſt thirty years of age being attack'd by it; which laſt obſervation has been, alſo, made by ſeveral late phyſicians. We may add, what learned men of the faculty have noted, at ſeveral times, concerning plagues, that particularly invade thoſe of this or that nation, tho' confuſedly mix'd with other peo-

Contagious diſeaſes occaſioned by the air.

people. *Cardan* ſpeaks of a plague at *Baſil*, with which only the *Switzers*, and not the *Italians*, *French*, or *Germans*, were infected. And *Johannes Utenhovious* takes notice of a cruel plague at *Copenhagen*, which, tho' it rag'd among the *Danes*, ſpared the *Engliſh*, *Dutch*, and *Germans*; who freely enter'd the infected houſes, and were not careful to avoid the ſick. But I muſt not be underſtood to impute theſe effects merely to the noxious ſubterraneal fumes; for I am far from denying, that the peculiar conſtitutions of men are likely to have a great ſhare in them; yet it ſeems leſs probable, that the peſtilential venom, diffuſed thro' the air, ſhould owe its enormous and fatal efficacy to the exceſs of the manifeſt qualities of the air, than to the peculiar nature of the peſtilential poiſon breath'd from the bowels of the earth; which poiſon, when it is, by dilution, or diſſipation, enervated; or by its progreſs, paſt beyond the air we breathe in, or render'd ineffectual by ſubterraneal or other corpuſcles of a contrary quality, the plague, which it produced, either quite ceaſes, or degenerates into ſomewhat elſe. And thus, perhaps, ſome of thoſe diſeaſes, called new, which either began to appear, or raged within theſe two or three centuries, as the ſweating-ſickneſs, in the fifteenth century, the ſcurvey and the *Morbus Hungaricus*, the *Lues Moraviæ*, *Novus morbus Luneburgenſis*, and ſome others, in the laſt century, may be in part cauſed by the heterogeneous ſteams we are here conſidering.

Uſes of this doctrine of ſubterraneal and celeſtial effluvia in the air.

And now if our two ſuſpicions about ſubterraneal and ſiderial effluvia ſhall prove well grounded, they may lead us to farther thoughts about things of no mean conſequence; three of which I ſhall here mention. And 1. we may hence take occaſion to conſider, whether ſeveral changes of temperature and conſtitution in the air, both as to manifeſt and latent qualities, may not, ſometimes, be derived from the ſcarcity, or plenty, and peculiar nature of one or both of theſe ſorts of effluvia. We find, in the moſt approved writers, ſuch ſtrange phenomena to have, ſeveral times, happen'd in great plagues and contagious diſeaſes, fomented and communicated, nay, began by ſome latent peſtiferous, or other malignant conſtitution of the air, as have obliged many of the moſt learned of them to have recourſe to the immediate operation of the angels, or of the power and wrath of God himſelf; or at leaſt to ſome unaccountable influence of the ſtars. But none of theſe ſolutions ſeem preferable to what may be gather'd from our conjecture; ſince of phyſical agents, whereof we know nothing ſo much as that they are to us inviſible, and, probably, of a heterogeneous nature; it need be no great wonder, that the operation ſhould, alſo, be abſtruſe, and the effects uncommon. And there are clearer inducements to perſuade us, that another quality of the atmoſphere, its gravity, may be alter'd by unſeen effluvia aſcending from the ſubterraneous regions of our globe. We have often perceived, by the mercurial barometer, the weight of the air to be conſiderably increaſed, when we could not perceive in the air, nor ſurface of the earth, any cauſe to which we might aſcribe ſo great a change. And I have ſometimes doubted, whether even the ſun it ſelf may not now and then alter the gravity of the atmoſphere, otherwiſe than by its rays or heat. I deſired ſome gentlemen of my acquaintance to aſſiſt me to diſcover, whether ſome of the ſpots that appear about the ſun, may not, upon their ſudden diſſolution, have ſome of their diſpers'd matter thrown off as far as our atmoſphere; and that in a quantity ſufficient to produce ſome ſenſible alterations in it, at leaſt as to gravity.

2. Another thing which our two forementioned ſuſpicions, if allow'd of, will ſuggeſt, is, that poſſibly ſome bodies we are converſant with, may have a peculiar diſpoſition and fitneſs to be wrought on by, or to be aſſociated with ſome of thoſe foreign effluvia, emitted by unknown bodies, lodg'd under ground, or that proceed from ſome particular planet. For what we call antipathies, depending really, on the peculiar textures, and other modifications of the bodies, between which theſe friendſhips and hoſtilities are ſaid to be exercis'd, I ſee not why it is impoſſible, that there ſhould be an affinity betwixt a body of a fit or convenient texture, eſpecially as to the ſhape and ſize of its pores, and the effluvia of any other body, whether ſubterraneal or ſidereal. We ſee, that convex burning glaſſes, by virtue of their figure, and the diſpoſition of their pores, are fitted to be pervaded by the rays of light, and to refract them, and thereby to kindle combuſtible matter; and the ſame rays of the ſun will impart a ſplendor to the *Bolonian* ſtone. And as for ſubterraneal bodies, we have ſometimes ſhewn, that two minerals being prepared in a peculiar manner, the ſteams of the one aſcending without adventitious heat, and wandering thro' the air, will not ſenſibly work on other bodies; but if they meet with a body that we prepared, they immediately operate upon it; and the effect will be both manifeſt and laſting.

3. The third thing ſuppos'd by our ſuſpicions is, that if they are well founded, it may be conſider'd, whether among the bodies we are acquainted with here below, there are not ſome that may prove receptacles, if not alſo the attractives of ſidereal, and other foreign effluvia, that rove up and down in our air. By attractives, I here mean, ſuch magnetical bodies as are fitted to detain, and join with effluvia; when, by virtue of the various motions that belong to the air as a fluid, theſe happen to accoſt them. Thus in making oil of tartar *per deliquium*, tho' the fiery ſalt is ſuppos'd to draw to it the aqueous vapours, yet indeed it does but arreſt and incorporate with ſuch of thoſe that wander thro' the air, as come in their paſſage to accoſt it. And without receding from the corpuſcularian principles, we might allow ſome of the bodies we ſpeak of a great reſemblance to magnets; which may, upon the bare account of adheſion, by juxta-poſition, or contact, detain the effluvia that wou'd glide along them; and there may be the more

firmly arreſted, by a kind of precipitating faculty of the magnet, with regard to ſuch effluvia; nay, 'tis poſſible in ſome circumſtances of time and place, that one of our magnets may, as it were, fetch in ſuch ſteams, as wou'd indeed paſs near it, but wou'd not otherwiſe come to touch it. Thus I have made bodies, not all of them electrical, attract, without being excited by rubbing, *&c.* far leſs light bodies than the effluvia we are ſpeaking of.

SECT. II.

Celeſtial and erial magnets.

SEVERAL bodies, which experience aſſures us imbibe or retain ſomething from the air, as calcined minerals, marcaſites, ſalts, factitious and natural, *&c.* may be often expos'd to it, and then weigh'd again, and farther diligently examined, whether that which makes the increaſe of weight be a mere imbibed moiſture, or ſomewhat elſe; and likewiſe, whether it be ſeparable from the body or not, or have endow'd it with any conſiderable quality. And experiments may be varied with a good magnet, by expoſing it long to the air, in regions differing much in climate, ſoil, or both; by expoſing it by day only, or by night, at ſeveral ſeaſons of the year, in ſeveral temperatures of the air, at ſeveral conſiderable aſpects of the ſtars and planets, by making it more or leſs frequently part with what it has gained from the air; and in ſhort, by having regard to that variety of circumſtances which human ſagacity will ſuggeſt. For by thus diverſifying the experiment many ways, we may, perhaps, by one or other of them, make ſome unexpected, and yet important diſcovery, of the effluvia wherewith the air in particular places, at particular times, abounds; and perhaps too of ſome correſpondence between the celeſtial and terreſtrial globes of the world.

Theſe, perhaps, will ſeem extravagant thoughts; but if I had been fortunate in preſerving all my obſervations, or other fruit, of ſome experiments I once made of this kind, it wou'd keep them from appearing ridiculous. To ſhew, however, that the air may not only have a notable operation upon vitriol, even after a ſtrong fire could work no farther on it; and that this operation was conſiderably diverſify'd by circumſtances; I ſhall make uſe of an obſervation of the experienced *Zwelfer*, who informs us; that "the colcothar of this mi-
" neral, made by a ſtrong diſtillation, is not corroſive; and that no
" ſalt can be obtained from it ſoon after diſtillation, by the affuſion of
" water; but, ſays he, if it be for ſome time expos'd to the air, it
" will yield a ſalt, which is ſometimes white, ſometimes of a beautiful
" purple colour; and this I have obtain'd in large quantities, and
" ſometimes alſo a nitrous kind."

This teſtimony has much the more weight with me, becauſe I find what he affirms of the ſaltleſſneſs of vitriol, newly and ſtrongly calcined, to be very agreeable to ſome of my experiments upon colcothar of blue vitriol; which is ſo odd a concrete, that I more than once recommended the making experiments upon it to ſeveral curious perſons; one of whom, an induſtrious man, and vers'd in chymical operations, aſſured me, that not only he had different kinds of ſalts from colcothar expos'd to the air for many months, and robb'd at convenient times of what it acquired; but that in tract of time he found it ſo alter'd, that he obtain'd from it a conſiderable quantity of true running mercury.

Obſervation to be made on colcothar.

But there are two or three things that I wou'd deſire to be obſerv'd about this odd *Caput mortuum.* The firſt is, that ſome circumſtances be regarded, which moſt obſervers wou'd overlook; ſuch as the temperature of the air, the month of the year, the winds, the weight of the atmoſphere, the ſpots of the ſun, the moon's age, her place in the zodiac, and the principal aſpects of the planets, and other chief ſtars: for tho' it be a boldneſs to affirm, that any, or perhaps all theſe together, will be concern'd in the production of the ſalt, or other ſubſtance to be made or diſclos'd in the colcothar; yet in things new and exorbitant, it may be ſometimes raſh and peremptory, to deny even ſuch particulars as cannot without raſhneſs be poſitively aſſerted; and in our caſe,the ſmall trouble of taking notice of circumſtances, will be richly rewarded,by the leaſt diſcovery made in things ſo abſtruſe and conſiderable. And as we cannot yet pronounce ſo much as negatively, whether the libration of the moon, and the motion of the ſun, and perhaps of ſome of the other planets, about their own centers, and conſequently their turning ſeveral parts of their bodies to us, may have an operation upon our atmoſphere; ſo, for ought I know, there may be in thoſe vaſt internal parts of the earth, whoſe thin cruſt only has been here and there dug into, conſiderable maſſes of matter having periodical revolutions, accenſions, eſtuations, fermentations, or in ſhort, ſome other notable commotions; whoſe effluvia may produce effects yet unobſerv'd on the atmoſphere, and on ſome particular bodies expos'd to it; tho' theſe periods may, perhaps, be altogether irregular, or have ſome kind of regularity, different from what one wou'd expect. Thus the ſea has thoſe grand intumeſcencies, we call ſpring-tides, not every day, nor at any conſtant day of the month or week, but about the full and new moon; and theſe ſpring-tides are moſt notably heighten'd, not every month, but twice a year; at or about the vernal and autumnal equinoxes: which obſervations are not near ſo ancient, and ſo well known, as the daily ebbing and flowing of the ſea. The eteſians of the ancients I ſhall not now inſiſt on, nor the obſervations of the elder inhabitants of the *Caribbee* iſlands; who, when the *Europeans* firſt reſorted thither, had hurricanes but once in ſeven years; afterwards they were moleſted with them once in three years; and of late they are troubled with them almoſt every year. And a phyſician who lived there, told me, me, he had ſcarce ever obſerv'd them to ſucceed one another in a leſs compaſs than of two months. In which inſtances, and ſeveral others that may be noted, of what changes happen to great quantities of matter, nature ſeems to affect ſomething of periodical; but not in a way that appears to us regular. We may add, what the learned *Varenius* relates of thoſe hot ſprings in *Germany*, he calls *Thermæ piperinæ*, of which he affirms this peculiarity, that they annually begin and ceaſe to flow at certain ſeaſons; the former about the 3^d^ of *May*; and the latter near the middle of *September*; from which time they reſt till the following ſpring. And *Johannes de Laet* tells us, that "in the *Mexican* "province *Xilotepec*, there is a ſpring which runs for four years ſuc- "ceſſively, and remains dry for the four following; when it again "breaks out afreſh; and which, ſays he, is ſtrange, it affords leſs water "on rainy days, than it does in clear, dry weather."

And thus much may invite us to take notice of circumſtances in our obſervations on colcothar; which might with the greater hopes of ſucceſs be kept long expos'd, becauſe bars of windows, and other erect irons, have been found in tract of time to acquire a ſettled magnetiſm from the effluvia of the earth.

The other principal thing I wou'd recommend is, that notice be taken not only of the kind of vitriol, whereof the colcothar is made, as whether it be blue *Dantzick* vitriol, vitriol of iron, *Hungarian*, *Roman*, &c. but alſo to what degree the calcination is made, and how far the calcin'd matter is freed from the ſalt by water. For theſe circumſtances, at leaſt in ſome places, will be of moment, and may perhaps afford hints of the conſtitution of the atmoſphere in particular parts, as well as of the beſt preparation of colcothar for detaining the foreign effluvia. And I wou'd the rather have experiments try'd again in other places with colcothar not calcin'd to the utmoſt, nor yet ſo exquiſitely edulcorated, but that ſome ſaline particles ſhou'd be left in it for future increaſe; becauſe I have more than once purpoſely try'd, in vain, that the *Caput mortuum* of blue vitriol, whereof the oil and other parts had been driven off with a violent and laſting fire, wou'd not, when freſh, impart any ſaltneſs to water; nor do I think, that out of ſome ounces purpoſely edulcorated, I obtained one grain of ſalt: and this inſipid colcothar being expos'd, ſome by me, and ſome by a friend who had conveniency in another place not far off, to the air, ſome for many weeks, and ſome for ſeveral months; we did not find it to have manifeſtly increas'd in weight, or to have acquired any ſenſible ſaltneſs; which, ſuppoſing the vitriol to have nothing extraordinary, gave me the ſtronger ſuſpicion of ſome peculiarity in the air of that part of *London*, where the trials had been made; at leaſt, during thoſe times wherein we made them; becauſe not only former experiments made here in *England* had aſſured me, that ſome colcothars will gain a conſiderable addition of weight, by being expos'd to the air; but accidentally complaining of my diſappointment to a traveller, who had in many countries examined their vitriols, aſſured me, that tho' he uſually dulcify'd his colcothar very well, yet within 4 or 5 weeks he found it conſiderably impregnated by the air whereto it was expos'd.

It remains, that I add one intimation more about vitriol; for ſince it has ſo great a correſpondence with the air, as I have found, it wou'd not be amiſs to try, not only colcothar of different vitriols, whether barely made the common way, or without any metalline addition to the vitriol-ſtones or ore; but other preparations of it too, as by expoſing vitriol, only calcined to whiteneſs by the ſun-beams; or further to an higher colour, by a gentle heat, or throughly calcined, and then impregnated with a little of its own oil: for ſuch vitriolic ſubſtances as theſe the air may work upon; nay, even liquid preparations of vitriol may be peculiarly affected by the air, and thereby perhaps be uſeful to diſcover the preſent conſtitution, or foretel ſome approaching changes of it.

A great effect of the air in producing colour.

In making a compoſition with ſublimate, copper, and ſpirit of ſalt, whereby I obtained a liquor of a beautiful green, I found the air had ſo much intereſt in the production of the colour, that when I had made the ſolution of the copper and mercury with the ſpirit of ſalt, that ſolution was not ſo much as greeniſh, as long as I kept it ſtopp'd in the glaſs wherein 'twas made: but if poured into a vial, which not being ſtopp'd, leaves it expos'd to the air, it after a while obtains that delightful green we ſpoke of. This experiment I repeated ſeveral times, and found the ſolution, till the air made it flouriſh, to be of a muddy reddiſh colour; ſo that having once kept ſome of the liquor, in the ſame glaſs egg wherein the ſolution had been made, it look'd like very dirty water; whilſt the other part of the ſame ſolution, having been expoſed to the air, reſembled the colour of an emerald. In which change 'tis remarkable, that to clarifie this liquor, and give it a tranſparent greenneſs, I perceiv'd not that any precipitation of foul matter was made, to which the alteration cou'd be aſcribed; yet to render it the more manifeſt, that this change proceeded not from a ſubſidence made of ſome darkening matter, effected by reſt; I kept ſome of the ſolution ſealed up in a fine vial for ſeveral months, without finding it at the end of that time other than of a dark or muddy colour; which it ſoon ceas'd to be, when the hermetic ſeal being broken off, the air was permitted to work upon it. And I further obſerved in our various experiments on this liquor, that according to the quality of the matter, and other circumſtances, the greenneſs was not attain'd to but at certain periods of time; now and then diſcloſing it ſelf within two or three days, and ſometimes not till after nine or ten.

The method of making this green liquor being troubleſome, the following may ſerve in its ſtead; tho' perhaps it will not ſucceed ſo conſtantly as the other. We took, more than once, filings of clean, crude copper, and having put on them a convenient quantity of good ſpirit of ſalt, we ſuffer'd the menſtruum to work upon the metal, which it uſually does ſlowly, and not like *Aqua fortis*. When the liquor had, by this operation, acquir'd a thick, muddy colour, we decanted it into a clean wide-mouthed glaſs, which being left for a competent time in the open air, the expoſed liquor became of a fair green; tho' it did not appear that any thing was precipitated at the bottom to make it clear.

With how little confidence of ſucceſs, trials that have the aims of theſe are to be attempted, conſideration and experience have made me ſenſible; yet I would not diſcourage mens curioſity from venturing even upon ſlight probabilities, where the deſign and the nobleneſs of the ſubject may make even ſmall attainments very deſirable. And till trials have been made, on occaſions of great moment, 'tis not eaſie to be ſatisfied, that men have not been wanting to themſelves. What experiments I have made, relating to this ſubject, I ſhall here ſet down.

Experiments to manifeſt ſome latent qualities in the air.

1. Having occaſion to dulcify ſome calx of *Dantzick* vitriol, from which the oil had been long before diſtilled; water was put upon two large portions of it, that the liquor might be impregnated with the vitriolic particles remaining in the calx; the water, put upon one of theſe portions, was, ſoon after, being ſufficiently impregnated, filtred, and gently abſtracted; by which means it afforded a kind of ſalt of vitriol, that ſeem'd to differ very little from the vitriol which had been calcined. But the water, put upon the other portion of calcin'd vitriol, was, in a wide-mouth'd veſſel, left in the air for a month or ſix weeks, after which time, when it came to be abſtracted, it afforded many drams of a ſalt, that did not then, nor long after, look at all like common vitriol, or like the other; but ſhot white, almoſt like ſalt-peter, or ſome other untinged ſalt. Whether this experiment will conſtantly ſucceed, and at other ſeaſons of the year than in the ſummer, wherein 'twas made, I had not the opportunity to try fully. But that the air may have a great ſhare, in varying the ſalts, obtainable from calcined vitriol, ſeems the more probable, becauſe we had a parcel of colcothar that had lain for ſome years in the air, ſhelter'd from the rain; and cauſing a lixivium to be made of it, we found, when the ſuperfluous moiſture was exhaled, that its ſaline particles began to ſhoot into ſalt far more white than vitriol, and very different from it in its figure and way of concretion.

2. Exactly weighing an ounce of the colcothar of vitriol of copper, carefully dulcified, and left in my ſtudy at *Oxford*, during the months of *January* and *February*, and expoſing it to the air for ſome weeks, we found it to have thereby gained four grains, and about a quarter, beſides ſome little duſt that ſtuck to the glaſs. This experiment, compared with the following, will ſhew, that the difference of airs, ſeaſons, calces of vitriol, or other circumſtances, may produce a notable diſparity in the increaſe of the weight gain'd by the bodies expoſed to the air.

3. We put eight ounces of foreign vitriol, calcined to a deep redneſs, into a broad flat metalline veſſel, and ſet it upon a ſhelf, in a ſtudy that was ſeldom frequented; and at the ſame time, to obſerve what increaſe would be made by expoſing to the air a larger ſuperficies of the powder, with regard to its bulk, we put into another metalline veſſel, ſmaller than the other, only two ounces of colcothar, and ſet it on the ſame ſhelf with the other. This was done on *March* 12; and on *June* 25 we weigh'd theſe powders again, and found the eight ounces to have gained one dram and ſeventeen grains; and the two ounces had acquired the ſame weight within a grain; then putting them back into their former veſſels, we left them in the ſame place, as before, till *Auguſt* 24; when we found cauſe to ſuppoſe, that the greater parcel of colcothar had met with ſome miſchance, either by mice or otherwiſe; but the leſs weighed twenty ſix grains heavier than it did in *June*, amounting now to two ounces one dram forty two grains; having increaſed in leſs than ſix months above a hundred grains, and conſequently, above a tenth part of its firſt weight. No trial was made to diſcover what this acquired ſubſtance might be, leſt we ſhould thereby diſturb the intended proſecution of the experiment.

4. Becauſe in moſt of theſe experiments of ſubſtances expoſed to be impregnated by the air, or to detain its ſaline or other heterogeneous particles, we employed bodies prepared and much altered by the operation of the fire, we thought fit to make ſome trials with ſuch as were unchang'd by the fire; and to this purpoſe, we took ſeveral ſmall lumps of a marcaſite, which was partly of a ſhining, and partly of a darkiſh colour, and which ſeemed well diſpoſed to afford vitriol, amounting to two ounces; theſe were kept in a room where they were freely acceſſible to the air, which was eſteemed to be very pure. After the marcaſites had been kept in this room, ſomewhat leſs than ſeven weeks, we weighed them again, in the ſame balance, and found the two ounces increas'd by above twelve grains.

5. I once or twice obſerv'd the fumes of a ſharp liquor to work more ſuddenly or manifeſtly on a certain metal, ſuſtain'd in the air, than did the menſtruum it ſelf that emitted thoſe fumes on thoſe parts of the metal it covered. And a chymiſt, who had been in *Hungary*, and other parts, purpoſely to viſit mines, aſſured me, that as to the ladders and other wooden work, employed in one or more of the deep *Hungarian* mines, thoſe that were in the upper part of the grooves, near the external air, would, by the fretting exhalations, be render'd unſerviceable, in a few months; whilſt ſuch ladders, pieces of timber, *&c.* which were employed in the lower part of the mine, would hold good for two or three times as long.

6. A certain ſoft but conſiſtent body, about the bigneſs of a nutmeg, chymically prepared, and which, in the free air, would continually emit a thick ſmoke, being put into a vial, and placed in a middle ſiz'd receiver on our pneumatic engine, continued for ſome time to

afford manifeſt fumes, whilſt the air was exhauſting, till at length the viſible aſcent of fumes, out of the vial, quite ceaſed; and the matter having remained for ſome time in this ſtate, the ſmoking ſubſtance was ſo altered as to emit no more fumes, not only when the air was let into the receiver, but for a conſiderable time after the vial was taken thence, till it had been removed to the window; where the wind blowing in freſh air, it began to ſmoke as formerly. And this ſubſtance having been kept in a large glaſs, into which it was diſtill'd, at leaſt for five or ſix weeks, would ſmoke very plentifully upon the contact of the air, yet be kept from ſmoking, tho' the chymical receiver were ſtopp'd but with a piece of paper. Nay, farther, when a vial, containing ſome of it, was put, unſtopp'd, in the receiver of our air-pump, cloſe luted on, tho' no exhauſtion were made, yet the white fumes immediately ceas'd to aſcend, as if the ſmoke participated of the nature of flame, and preſently glutted the air, or otherwiſe made it unfit, without diminiſhing its gravity, to raiſe the body.

The growth of metals expoſed to the air in their ore.

Let us next conſider the generation of metals. But I deſign not to examine, whether metals and minerals, as if they were a kind of ſubterraneal plants, properly grow like vegetables; I here take the growth of metals in a looſe popular ſenſe, wherein a metal may be ſaid to grow, if an aſſigned portion of matter, which yet either diſcovers no metal, or but ſuch a quantity, as, being expoſed to the air, will, after a time, afford ſome, or a greater proportion than it had before.

The growth of tin.

An ancient owner of mines aſſured me, he could, otherwiſe than upon vulgar conjecture, prove, that minerals grow even after the veins have been dug; and being deſired to let me know his proofs, he gave me theſe that follow: firſt, he ſaid, that not far from his houſe there was a tin-mine, which the old diggers affirmed to have been left off, ſome ſaid eighty, ſome a hundred and twenty years ago; becauſe they had, by their waſhing and vanning, ſeparated all the ore from the reſt of the earth; yet, of late years, they found it ſo richly impregnated with metalline particles, that it was wrought over again with very great profit, and prefer'd to ſome other mines that were firſt wrought without having been ever ſo robb'd. And when I objected, that, probably, this might proceed from the lazineſs and unſkilfulneſs of the workmen in thoſe times, who left in the earth, the tin that was, or might be ſeparated; he anſwered, 'twas a known thing in the country, that in thoſe times the miners were more careful and laborious to ſeparate the metalline part from the reſt of the ore than now. He alſo affirmed, that in his own time, ſome tenants and neighbours of his, having got all the ore they could from a great quantity of ſtuff dug out of a tin-mine, they laid the remains in large heaps, expoſed to the air, and, within twenty five years after, found them ſo richly impregnated, that they wrought them over again,

again to better advantage. And, laſtly, he aſſured me, that in a work of his own, wherein he had exercis'd his skill and experience to ſeparate all the particles of the tin, from the terreſtrial ſubſtances dug up with it out of the vein, he caus'd dams to be made to ſtop the earthy matter which the ſtream waſh'd away from the ore, giving paſſage to the water, after it had let fall this ſubſtance; which lying in heaps expos'd to the air, within 10 or 12 years, and ſometimes much leſs, he examin'd this or that heap, and found it to contain ſuch ſtore of metalline particles, as invited him to work it again, which he did with profit. Yet this gentleman was ſo dextrous at ſeparating the metalline, from the other parts of tin-ore, that I cou'd not without wonder ſee what ſmall corpuſcles he wou'd, to ſatisfie my curioſity, ſever from vaſt quantities of earthy and other mineral ſtuff.

Relations agreeable to theſe I received from another very ingenious gentleman, who was skill'd in tin-mines, and lived not far from ſeveral of them.

I was the more ſollicitous to procure an information about the growth of this metal, becauſe the greateſt part of that uſed in *Europe*, being met with in *England*, I have found no mention made of the growth of it in foreign writers.

The growth of lead.

A perſon of quality, who had a patent for ſeveral lead mines, ſuppos'd to contain ſilver, and who wrought ſome of them himſelf at no ſmall charge, yet not without profit, aſſured me, that the lead-ore which had been wrought, and laid in heaps, did, in tract of time, become impregnated with metal again; and, as experience manifeſted, proved worth working a ſecond time. And indeed, ſome mineraliſts deliver it as a general obſervation, that the growth and ſecond generation of metals, is more manifeſt in lead, than in any other of them. *Boccatius Certardus* delivers it as a thing certainly known of a mountain near *Florence*; that "if the lead-ſtones it contains be dug up, others in time "will grow in their places." And *Agricola* ſpeaking of the growth of mines in general, tells us, that "the paſſages of them have in a ſhort "time been ſtraitned, and grown together by the increaſe of their "matter." But I doubt this increaſe of lead is not obſervable in all mines of that metal; becauſe a gentleman, whoſe houſe was ſeated near ſeveral lead-mines, and who was himſelf owner of one or two, aſſured me, that in the country where he lives, he never obſerved the lead-ore to increaſe, either out of the veins, nor in them; and that in ſome places, where ore had been dug 30 or 40, if not 50 years before, he perceiv'd not on the ſides of the paſſages whence the ore had been taken, that any other had grown in its ſtead; or that the paſſages, tho' narrow before, were ſenſibly ſtraitned, much leſs block'd up. And, indeed, if there were no other arguments in the caſe, the ſtraitning of the ancient paſſages in proceſs of time, wou'd not convince me of the growth of metals; for the ſoils that abound with them uſually alſo abound with waters, which are commonly imbibed by the neighbouring earth; and this water is expanded, by being turned into ice; and this expanſion is made with an exceeding great force, by which it often ſtretches, or breaks through the things that contain it; whence 'tis probable, that ſometimes the narrowneſs of the ſubterraneal paſſages in mines,may proceed from the water imbibed by the ſurrounding ſoil, and being frozen in ſharp winters: for by this means the ſoil muſt forcibly endeavour to expand it ſelf, and actually do ſo in the parts contiguous to the paſſage, ſince there it finds no reſiſtance; and tho' the expanſion made in one year or two be but ſmall, and therefore not obſerv'd, yet in a ſucceſſion of many winters, it may, by degrees, grow to be very conſiderable. But Dr. *Brown*, in his travels, ſpeaking of a mine, has theſe words: “ Some paſſages in this mine cut thro' the “ rock, and long diſuſed, have grown up again; and I obſerv'd the “ ſides of ſome which had been formerly wide enough to carry their “ ore thorough, to approach each other; ſo that we paſs'd with diffi- “ culty. This happens chiefly in moiſt places; and the paſſages unite “ not from the top to the bottom, but from the ſides.” Upon the whole; I take the argument drawn from the increaſing ſtraitneſs of the paſſages in mines, to make more for the growth of metals, than what is much relied on by ſome writers, who urge, that in churches, and other magnificent buildings that are leaded over, the metalline roofs, in a long tract of years, greatly increaſe in weight; ſo that often there is a neceſſity to remove them. For having had ſome occaſion to obſerve and enquire after this kind of lead, I ſoon ſuſpected, that the increaſe of weight, which ſometimes, indeed, may be very great, was no clear proof of the real growth of the metal it ſelf. In that which I had occaſion to conſider, the additional weight, as well as bulk, ſeem'd to proceed from ſharp, or other ſaline corpuſcles of the timber of the buildings; which by degrees exhaling and corroding that ſide of the lead whereon they faſtened, turned it with themſelves into a kind of ceruſe. For, 1. I have found by trial purpoſely made, that woods afford an acid, tho' not a merely acid liquor, capable of corroding lead. 2. 'Tis known, that lead turned into ceruſe, gains conſiderably in weight; ſome ſay ſix or ſeven pound in the hundred. 3. From the ſheets of lead that have very long cover'd churches, and the like buildings, there is often obtained, by ſcraping, a large proportion of white lead, which I have known much preferr'd by an eminent artiſt, to common ceruſe, when a white pigment was to be employ'd. And, by the way, men finding this ceruſe, not on that ſide of the lead which is expos'd to the external air, where I ſcarce ever obſerved any, but on the inſide that lies on the timber, and other wooden work, it may diſabuſe thoſe who fancy this ceruſe to be a part of the lead calcined by the beams of the ſun. And if to this be added, that by diſtillation, and otherwiſe, I have found cauſe to ſuſpect, that alabaſter and white marble may emit ſpirituous parts, which will invade lead; it may be doubted, whether what *Galen* relates of the great intumeſcence of the leaden bands, wherewith the feet of ſtatues were faſten'd to their pedeſtals, be a ſure argument of the real growth of that metal in the air.

The growth of iron.

I cou'd not find in one of our chief iron-mines, that there was any notice taken of the growth of iron; but in another place or two, ſome who deal in iron-ore informed me, that they believe it grows, and may be regenerated; and upon that account one of them ſet up a work contiguous to ſome land of mine, to melt over again the remainder of ore that had been already wrought at a great diſtance from that place; and had for ſome ages lain in heaps expos'd to the free air. But of the growth of iron in the iſland of *Ilva* in the *Tyrrhene* ſea, near the coaſt of *Tuſcany*, not only ancient writers, as *Pliny* and *Strabo*, take particular notice; but modern mineraliſts of very good credit, as *Fallopius* and *Cæſalpinus*. The latter tells us, that "an incredible quantity was there " produc'd in his time; and that even the earth which they throw up " in digging the vein, after a while becomes a vein it ſelf." *Agricola* gives us the like account of a place in *Germany*; and the learned *Joh. Gerhardus* aſſures us, he was told by one who dug in the iron-mines near *Amberg*, that " the mere earth there dug up with the ore, being mix'd " with the droſs of the iron, and thrown in heaps, expos'd to the ſun, " and the rain, uſually in 15 years time afforded, by melting, a thin " kind of iron fit only for plates."

The growth of ſilver.

In a *French* collection of voyages, publiſhed by a perſon of great curioſity and induſtry, there is an account given by a gentleman, of a late voyage he made to *Peru*. This gentleman informs us, that the beſt ſilver in all the *Indies*, and the pureſt, is that of the mines of *Potoſi*; where they draw this metal even from the mineral earths; which were formerly thrown aſide, when the ground was opened, and the grooves and ſhafts in the mountains made; metal having been obſerv'd to be form'd in them afreſh ſince thoſe times; which ſufficiently ſhews the propenſity of the ſoil to the production of this metal: yet 'tis true, adds he, that theſe impregnated earths yield not ſo much as the ordinary ore found in veins betwixt the rocks.

The growth of gold.

As for the growth of gold, the inquiries I have yet made, among travellers, give me no great ſatisfaction about it; and tho' I have diſcours'd with ſeveral who had been at *Guinea*, *Congo*, and other parts of *Afric*, where much gold is to be had; yet I cou'd not learn, that they, or any acquaintance of theirs among the natives, had ſeen any mines or veins of gold. And afterwards meeting with a learned traveller, who had carefully viſited the famous gold-mine at *Cremnitz* in *Hungary*, he aſſured me, he cou'd not learn from the miners, whether or no the ore of gold, *&c.* did really grow, or were regenerated in tract of time, by being expos'd to the air, or upon any other account. But the grand overſeer, who was lord of part of the ſoil, told him, that he thought the whole mountain abounded with particles of gold; and therefore when the diggers had almoſt exhauſted a vein, he there caſt in large

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quantities of earth, and fell to work upon other neighbouring places; whilſt that earth being kept there, as in a reſervatory, wou'd afterwards afford gold as the mine had done before. And a late *German* profeſſor of phyſic ſays, that "at *Corbac*, a city of *Weſtphalia*, they melt gold out "of their heaps of earth once in four years; in which time they find "it generated afreſh." "The common yellow earth of the country "near *Cremnitz*, ſays Dr. *Brown*, in his travels, eſpecially of the hills "towards the weſt, altho' not eſteemed ore, affords ſome gold. And "in one place, I ſaw a great part of a hill dug away, which had "been caſt into the works, waſh'd and wrought in the ſame manner, "as pounded ore, with conſiderable profit." I have alſo ſome fine gold that never endured the fire, taken out of tin-ore. But whether it be the contact or operation of the air, or ſome internal diſpoſition, analagous to a metalline ſeed or ferment, that cauſes this increaſe in metals, I dare not be poſitive; tho' the probable intereſt of the air herein, will ſufficiently excuſe my alledging theſe inſtances, as favourable to my ſuſpicion, till further experience ſhall have more clearly inſtructed us.

THE ORIGIN and VIRTUES OF GEMS.

SECT. I.

IN propoſing my conjectures about the virtues of gems, I ſhall not ſuppoſe the truth of thoſe wonderful properties that ſome have aſcribed to them; tho' not only writers of natural magic, but grave authors, have appeared in their favour. For my part, I never ſaw any great matters performed by thoſe coſtly ſtones, that are uſually worn in rings; yet becauſe phyſicians have, for many ages, received the fragments of precious ſtones into ſome of their moſt celebrated cordial compoſitions; and becauſe many eminent men, and ſome virtuoſi of my own acquaintance, have informed me of very conſiderable effects of ſome gems upon their own particular obſervations; and laſtly, becauſe it is not impoſſible that ſome of the ſofter ſtones may have conſiderable operations upon the human body, a few of which I am my ſelf convinc'd of, I dare not indiſcriminately reject all the medicinal virtues that tradition, and the writers upon precious ſtones, have aſcribed to them: but ſuſpecting moſt of their relations to be fabulous, I wholly aim to aſſign a cauſe of thoſe virtues aſcribed to gems, which experience warrants to be real and true.

Gems were once fluid, and have their virtues from mineral matter.

Having thus explained in what ſenſe my thoughts as to the virtues of precious ſtones are to be underſtood, I come to propoſe my hypotheſis about them; the ſubſtance of which may be comprized in theſe two particulars. Firſt, many gems and medicinal ſtones, either have once been in a fluid ſtate, or are in part made up of ſuch ſubſtances as were formerly fluid. Secondly, many of the real virtues of ſuch ſtones may probably be derived from the mixture of metalline, and other mineral ſubſtances, uſually incorporated with them; whilſt the great variety and efficacy of thoſe virtues may be owing to ſome happy concurrent circumſtances of that commixture. The former of theſe heads relates properly to the origin of gems; and the latter, partly to that, and partly to the kinds and degrees of their virtues.

But that any gems, eſpecially the hardeſt ſort, ſhould have a later beginning than the earth it ſelf, will, probably, appear a paradox; and I doubt not it will paſs with many for a great one, that ſome of theſe hardeſt of ſolid bodies, ſhould have once been fluids; but the following conſiderations will countenance this hypotheſis.

That gems were once fluid, argued from their tranſparency.

And firſt, the tranſparency of diamonds, rubies, ſapphires, *&c.* agrees very well with this conjecture, and thereby ſeems to favour it; for 'tis not ſo likely, that bodies which were never fluid, ſhould have their conſtituent parts ſet in the order requiſite to tranſparency as thoſe that were once in a liquid form; during which it is eaſie for the rays of light to make themſelves paſſages every way, and diſpoſe the ſolid corpuſcles after the manner neceſſary to the conſtitution of a tranſparent body. Thus we ſee, that ſilver diſſolved in *Aqua fortis*, or lead in ſpirit of vinegar, having thereby had their particles reduced to a fluid ſtate, thoſe particles, tho' before opake, are ſo diſpoſed as to make not only a diapanous ſolution, but, if deſired, tranſparent cryſtals; and the experiments that chymiſts uſually make with theſe metals, I have made with ſeveral ſtones. But this argument is produced rather to confirm, than prove my conjecture.

Figuration.

2dly, The origin I aſſign to gems, may be alſo countenanced by the external figuration of ſeveral of them. For we plainly ſee, that the corpuſcles of nitre, alum, vitriol, and even common ſalt, being ſuffered to coagulate in the liquors wherein they floated before, will convene into cryſtals of curious and determinate ſhapes. And the like I have tried in ſeveral metalline bodies, diſſolved in their reſpective menſtrua. But unleſs a concreting ſtone, or other like body, be either ſurrounded with, or in great part contiguous to a fluid, 'tis not eaſie to conceive how it ſhould acquire a curious, angular, and determinate figure. For concreſcent bodies, if they have not room enough in an ambient fluid for the moſt ſuitable ranging of their parts, cannot caſt themſelves into ſuch fine and regular ſhapes as ſeveral gems ſeem to affect; but the matter they conſiſt of, muſt conform to the figures of the cavity that contains it, which, in this caſe, has not ſo much the nature of a womb, as of a mould. Thus we ſee ſalt-peter, and ſeveral other ſalts, if the water they were diſſolved in be too far exhaled, before they are ſuffered to ſhoot, will, if the liquor fill the glaſs, ſometimes coagulate into a maſs, faſhion'd like the inſide of the containing veſſel; or if a conſiderable quantity of liquor remain after the coagulation, that part of the nitre which was reduced to concrete next the glaſs, will have the ſhape of the internal ſurface thereof; but the cryſtals contiguous to the remaining liquor, having a fluid ambient to ſhoot in, will have the part of their bodies contiguous to the liquor, curiouſly form'd into ſuch priſmatical ſhapes as are peculiar to nitre.

To apply this to gems. That many kinds of them have geometrical and determinate ſhapes, I have often obſerved, in viewing them as nature produced them; for I have had the good fortune to take ſeveral out of their wombs. And upon freeing a large number of *Indian* granats from a lump of heterogeneous matter, whoſe diſtinct cavities, like ſo many cells, contained ſtones; on ſome of their ſurfaces appeared triangles, parallelograms, *&c.* And from the rock, whence thoſe ſtones chiefly come, that are commonly called *Briſtol* ſtones, I procured a number of them to be dug up in my preſence; many of which appeared to be curiouſly and determinately figured, much like ſome cryſtals of nitre that I have taken pleaſure to compare with them. And the like configuration I have, alſo, obſerved in many *Corniſh* diamonds; and particularly in a fair large one found growing, with many leſſer, in *Ireland.* Nor is it only in theſe ſofter gems, that this curious figuration may be met with; for I found, among many ſtones which I took to be rubies, and which are exceeding hard, a conſiderable number, whoſe figure, tho' not the ſame with the *Corniſh* and *Iriſh* ſtones, were yet fine and geometrical. And the like I have obſerved even in diamonds themſelves; and particularly in a large one that was rough, I perceived the ſurface to conſiſt of ſeveral triangular planes, not exactly flat, but including, as it were, ſmaller triangles within them; that for the moſt part meet at a point, and ſeem to conſtitute a very obtuſe, ſolid angle. Encourag'd by this, I examined ſeveral other rough diamonds, and found moſt of them to have angular and determinate ſhapes, not unlike thoſe already mentioned. And having thereupon conſulted an expert jeweller, he told me, he generally found them to be ſhaped like that I ſhewed him; and added, that ſuch a ſhape was the mark by which he uſually judg'd a ſtone to be a right diamond, if he had not an opportunity to examine it by the hardneſs.

And, in favour of the compariſon betwixt the coagulation of ſalt-peter and that of gems; having once made an odd menſtruum, wherein I was able to diſſolve precious ſtones, there ſhot in the liquor pretty large cryſtals, ſo tranſparent and well ſhap'd, that they might eaſily have paſs'd for thoſe of nitre, but were, nevertheleſs, inſipid. And I have often taken notice in ſuch ſtones as the *Briſtol* diamonds, that tho' the part, which may be look'd upon as the upper, were curiouſly figur'd with ſix ſmooth ſides, which, at the top, ſhaped off ſo as to make ſix triangles, that terminated like thoſe of a pyramid in a point; yet that which may be look'd upon as the root, or lower part of the ſtone, was much leſs tranſparent, and of an irregular figure: the reaſon of which ſeems to be, that this being the part whereby the ſtone adhered to its womb, was ſull'ed by the muddineſs thereof, and reduced to conform it ſelf to the ſhape of the contiguous cavity; whilſt the upper part of the ſtone was not only form'd of the clearer portion of the petreſcent juice, before the wateriſh vehicle was exhaled, but had room and opportunity to ſhoot into the curious figure belonging to its nature. And this is much more conſpicuous, where many of theſe cryſtals grow in cluſters out of one mineral cake or lump. Thus I have ſeen it in thoſe ſoft tranſparent concretions which ſome of the late mineraliſts call *Fluores*; and particularly in a very fine mineral lump ſhew'd me by a great prince. For this maſs conſiſted of two flat parallel cakes, that ſeemed compoſed of a dirty kind of cryſtalline ſubſtance, and out of each cake there grew, towards the other, a great number of ſtones, ſome of which, by their coheſion, kept the two cakes together; and moſt of theſe ſtones, having each of them a little void ſpace about it, wherein it had room to ſhoot regularly, were geometrically ſhap'd and colour'd like a *German* amethyſt. And I have my ſelf a pretty large ſtone, taken up here in *England*, which conſiſts of four parts; the lowermoſt whereof is a thin broad flake of courſe ſtone, only adorned here and there with very minute glittering particles, as if they were of a metalline nature; over this is ſpread another thin white opake bed, which is ſo inclos'd between the former part and the two others, that, without defacing the ſtone, I cannot well examine it. The third conſiſts of a heap of minute cryſtals, exceedingly thick ſet, which therefore look whitiſh; having little or no tincture of their own; and this part, like the former, is not much thicker than a barly corn. The fourth and uppermoſt part, which ſeems, in great meaſure, to be the ſame cryſtals, that, as they grow higher and ſpread, acquire a deeper colour, is made up of a large number of amethyſts, ſome paler, and others highly tinged; which are of very different figures and magnitudes, according as they ſeem to have had conveniency to ſhoot; theſe, at one end of the ſtone, lie in a flat bed, ſcarce exceeding a barly-corn in length, whilſt thoſe, at the other end, ſhoot up to a conſiderable height into figur'd cryſtals, ſome of them as big as the end of my little finger, which were the moſt deeply colour'd, being alſo of a great hardneſs; for I found they would eaſily cut glaſs.

I remember, alſo, that from a famous quarry which ſtood near a ſpring, that had a petreſcent faculty, I caus'd ſeveral ſolid pieces of rough opake ſtone to be broken, in hopes of finding ſome finer juice therein coagulated into ſome finer ſubſtances; and accordingly I obſerved, that in ſeveral places the ſolid maſſy ſtone had cavities in it, all about the ſides whereof there grew concretions, which, by their limpidity and curious ſhape, ſeem'd to have been ſome finer petreſcent fluid, that by a kind of percolation thro' the ſubſtance of the groſſer ſtone, had, at length, arriv'd at thoſe cavities; and upon the evaporation of the ſuperfluous, aqueous parts, or by their being ſoak'd up by the neighbouring ſtone, had an opportunity to ſhoot into theſe fine cryſtals; which were ſo numerous, as quite to overlay the ſides of the cavities. And an ancient digger in theſe quarries told me, he had ſometimes met with greater quantities of them; and preſented me with a large lump or maſs, made up of numerous heaps of ſoft cryſtals ſticking to one another, but none of them to any part of the rock; ſo that they ſeemed to have been haſtily coagulated in ſome cleft or cavity, as it were in a mould; where meeting and mixing, before concretion, with ſome looſe particles of clay, the maſs might thereby be diſcoloured. And our argument drawn from the figuration of tranſparent ſtones, may be much ſtrengthened by that coalition I have ſometimes obſerved of two or more ſuch ſtones; and the congruity in the ſhape of ſome of them, to the figures of the contiguous parts of the others, that ſeemed to have been formed after them.

Internal texture.

3*dly*, The internal texture of theſe gems alſo favours our hypotheſis; ſome of them ſeeming much to imitate, in their coagulation, ſeveral of thoſe ſubſtances, which I have obſerv'd were once fluid. 'Tis eaſily obſerved, that common ſalt may conſiſt of ſmall ſaline particles, which by a convenient juxta-poſition are aſſociated into great lumps, ſeveral of which have a cubical figure. And that ſuch coalitions of particles may conſtitute ſolid and conſiderably hard bodies, I have tried by breaking ſome of the larger cubes of ſal-gem, and the lumps of *Mayo* ſalt; whereof the firſt is foſſil, the other marine, and both natural. I have, likewiſe, found by trial, that tho' ſilver diſſolv'd in *Aqua fortis*, uſually appears to ſhoot into flat, and exceeding thin flakes; yet 'tis very poſſible ſo to order the coagulation, that many of theſe thin plates ſhall, in their convention, have their flat ſides ſo placed over one another, as to make up pretty large and clear cryſtals, whoſe very outſides will be finely figured. And as theſe are not the only fluid bodies I have brought to coagulate into ſuch a flaky ſubſtance, I began to ſuſpect that many tranſparent minerals may have the like texture; and in ſome diaphanous kinds of talc, whoſe outſides were regularly figured, I found encouragement to try, whether even ſome gems, notwithſtanding their hardneſs, might not have ſuch an internal figuration. I was not deterred from this enquiry by its being generally ſuppoſed, that gems are of an uniform texture; and that there muſt be an immenſe thinneſs in the plates which compoſe tranſparent ſtones; ſince no ſuch thing as plates had been diſcovered by the moſt curious eye: and men having allow'd all gems to be uniform in their texture, without any grain or fibres more than there are in gold. But as to this thinneſs of the plates, I remember I have ſeveral times held a piece of good *Muſcovy* glaſs againſt the light, ſo thin, that a curious eye cou'd ſcarce diſcover the plate it ſelf, which therefore, by no means ſeemed capable of being ſplit; yet in this caſe I have ſometimes ſubdivided it beyond expectation. And having carefully examined ſome ſtones, that had geometrical figures on part of their ſurfaces, and which I had reaſon to think were once fluid ſubſtances, I manifeſtly perceived, with my naked eye, ſeveral parallel commiſſures therein; which ſeemed plainly to be made by the contiguous edges of little thin plates of ſtone, that appear'd to lie one over another, almoſt like the leaves of a book a little opened.

I remember alſo, that by holding a large, rough, grizolette, that is, a hard gem of a bluiſh colour, brought from *Eaſt-India*, againſt the light, and curiouſly obſerving it, I have ſometimes plainly diſcovered a grain, as they call it, therein; according to the tendency whereof, I have been aſſured by a skilful artiſt, who uſed to make ſeals of theſe ſtones, that they wou'd uſually ſplit. I forbear to urge, that in ſome other precious ſtones cut and poliſhed, as particularly the hyacinth and ſapphire, by turning them ſeveral ways to the light, I have obſerv'd commiſſures ſo fine, as not to prejudice the entireneſs of the ſtone for the lapidaries purpoſe; becauſe the phenomenon is far leſs conſiderable than what I have often obſerved in *New-Engliſh* granats; wherein, eſpecially when they are broken, the edges and commiſſures of the thin plates, or flakes, whereof they conſiſted, are very eaſily diſcernable. And to try whether this obſervation wou'd hold even in the hardeſt ſtones, I had recourſe to a pretty large, unwrought diamond; which being placed in a microſcope, ſhew'd me the commiſſures of the flakes I looked for, whoſe edges were not ſo exactly diſpos'd into a plain, but that ſome of them ſtood very ſenſibly extant, like little ridges, broad at the top, above the level of the reſt. And theſe parallel flakes, with their commiſſures, I cou'd in a large diamond plainly diſcern, even with my naked eye. And further, an eminent jeweller, and another artificer, whoſe trade it was to poliſh and cut diamonds, aſſured me, upon their repeated and conſtant experience, that 'twas almoſt impoſſible to ſplit diamonds ſmoothly, in a direction contrary to their grain; but eaſily, and at one ſingle ſtroke, with a ſteel tool, when once they had found in what line their inſtrument ſhould be impell'd. By this 'tis evident, that diamonds themſelves have a grain, or flaky contexture, not unlike that of wood, which will readily be granted to conſiſt of aſſimilated water or juices, that having been once fluid, were fit to have their particles ſo rang'd or diſpos'd, as to conſtitute a body far more eaſie to be cleft along the direction of its fibres, than in a way contrary thereto. And I remember, that having obſerved in a rough diamond, which I purpoſely examined, the flakes whoſe edges were terminated in one of its plains, to be far from running parallel to thoſe whoſe edges compos'd another; I imagined, that if this diamond were to be cleft, it wou'd not be ſmoothly ſplit into two pieces, becauſe the commiſſures probably made angles in the body of the ſtone; and accordingly, I learn'd of a diamond-cutter, that he ſometimes met with ſtones, which baffled all his skill, and wou'd by no means ſplit, like others, into two parts; but before they were cleft quite thorough, break in pieces. And this diſpoſition in the ſtone he cou'd not certainly foreſee.

Their colours being probably adventitious.

4*thly*, It ſeems not improbable, that the colours of ſome gems are adventitious, and were imparted to them either by ſome tinging mineral juice or exhalation, whilſt the ſtone was either *in ſolutis principiis*, or of an open texture. And this argument is too conſiderable to be ſlightly paſs'd over. For in the firſt place, a multitude of gems have been deprived of their colour, by continuing long in the fire; and the experienced *Boetius de Boot* affirms, that all gems will loſe their colour by this means, except *Bohemian* granats. How far this may hold true, I have not had opportunity thoroughly to examine; but I well remember, that having purpoſely expos'd ſeveral gems in a crucible, to a moderate fire, ſome of them ſeemed to have their tincture much impair'd, and others quite deſtroyed thereby. But if theſe trials be not warily made, they may eaſily impoſe upon us; eſpecially if we do not conſider the nature and cauſe of whiteneſs: for any diaphanous body, as far as I have yet obſerved, being divided into a multitude of very minute parts, and conſequently acquiring a multitude of diſtinct ſurfaces, which briskly reflect the light every way outwards, will appear to have a white colour, more or leſs vivid, as the particles are more or leſs numerous, minute, and otherwiſe fitted to ſcatter the incident rays. Thus fine *Venice* glaſs reduced to powder, will be white; and even red ink, if ſo ſhaken, as to be brought to a froth, conſiſting of many minute bubbles, will ſeem whitiſh: whence, if by too haſty an ignition or refrigeration of the gems, they come to be flaw'd with innumerable little cracks, they may be thought to become white by having their tincture driven away; when their whiteneſs really proceeds from the multitude of thoſe little flaws, which are ſingly unperceived; and this the rather, becauſe the body may ſtill retain its former ſhape, or ſeeming entireneſs. To illuſtrate this, I have ſometimes heated a piece of cryſtal red hot in a crucible, and then quenched it in cold water; for even when the parts did not fall aſunder, but the body retained its former ſhape, the multitude of little cracks that were by this operation produced in it, made it quite loſe its tranſparency, and appear a white body. In making this experiment, the multitude of the flaws produced may be rendered more viſible, if the heated cryſtal be warily and dexterouſly quenched in a very deep ſolution of cochineal, made with ſpirit of wine; whereby, if the operation be well perform'd, enow of the red particles of the ſolution will get into the cracks of the cryſtal, to give it a pleaſing colour.

(2.) The colours of ſeveral gems, when not deſtroyed by fire, will be altered thereby; which happening to ſeveral foſſil pigments, and other bodies, confeſſedly mineral, argues a mixture of mineral ſubſtances in the ſtones, whoſe colours receive thoſe alterations; for there may be a change of colour produced by the fire, without any alteration of the tinging parts conſidered in that capacity. Thus by flaming the heated gem, in very many parts, a degree of whiteneſs or paleneſs emerging thereupon, may ſomewhat change its former co-

Nat.Hist. lour: but this alteration being only a kind of dilution, is not that which I here mean. I have, by expoſing *Indian* granats, in a crucible, to the fire, found them exchange their reddiſh colour for a dark and dirty one, like that of iron long kept in the air. And having kept ſome pieces of agate prettily adorned with waves of different colours, for a competent time in the fire, I found, that the greateſt part of the agate ſeem'd to be depriv'd of its tincture, and reduc'd to a pleaſant whiteneſs. But in ſome places, where there were ſtains of a different kind from the reſt, and where there run little veins that I ſuſpected to be of a metalline nature, the colour was not deſtroyed, but changed; and the veins of the pigment acquir'd a deep redneſs, which they will retain, if let alone; tho' I was induced, by ſome trials I made on other pieces of *Indian* agate, to think, that even theſe metalline tinctures might be driven away by a more laſting fire, ſo as to leave the ſtones purely white. A like change of colour is, likewiſe, found in ſome other ſtones; as alſo, in ſome pebbles, amongſt ſeveral of which, that loſt only their tranſparency by ignition and extinction in water, one or two acquired a colour remarkably deeper than they had before.

(3.) Having borrowed an *Oculus mundi*, its colour white, figure round and plano-convex, and diameter about a third part of an inch; I put it into a very ſhallow glaſs-veſſel, almoſt fill'd with fair water, and obſerv'd within a minute, that one part of the edge began to appear ſomewhat tranſparent; and the whole ſtone, by degrees, loſt its whiteneſs, appearing of a dark browniſh colour. This change had reach'd the whole ſurface, by lying nine minutes in the water; then taking it out, I perceiv'd the body was grown half tranſparent, and the parts, near the edge, being leſs thick, appeared to have loſt much more of their former opacity than the innermoſt part. Then putting the ſtone preſently into the water again, I let it lie there till half an hour was expired from the beginning of the experiment; when, taking it out, and wiping it, I found it was grown much clearer; for being held againſt the light, it looked almoſt like yellow amber, but not quite ſo tranſparent. I next expoſed it to the air, in a very good balance (where it weigh'd four grains and about a quarter) and there left it for near half an hour, to try, if by the receſs of any imbib'd aqueous moiſture, it would become lighter; but I was hindered from compleating the experiment. Tho' this did not deter me from making another obſervation, which was, that within about a minute after, I found a portion of the ſtone, near one part of the edge, grown manifeſtly opake and whitiſh; and in a few minutes more the whole ſtone began to appear in a changing condition, but did not change in every part at once, nor did the alteration make an uniform progreſs; but one might ſucceſſively diſcover ſeveral white arches, or as 'twere zones, parallel to each other; and theſe being quite opake, intercepted between them other little zones, which being yet ſemi-opake, ap-

appeared of a brown colour, and concurr'd to make the ſtone look like a pretty agate, wherein the whiteneſs made a continual progreſs as long as the time permitted me to obſerve it: and the poſſeſſor aſſur'd me, that within an hour or two it would be all of a cream white. And indeed I ſaw one part of it, that was pretty broad, had already obtain'd a whiteneſs little inferior to that of ivory.

(4.) Another circumſtance which ſeems to favour our conjecture is, that it has been often obſerved, that where coloured gems are found, ſome mines or veins of metals are, alſo, to be met with. And I think it not unlikely, that, upon a skilful ſearch, many more diſcoveries would be made of veins, either of metalline ore, or ſome other mineral; whence, by means of juices or fumes, gems may be preſum'd to have received their tinctures. But uſually where precious ſtones are found, mens induſtry and curioſity is too much confined to thoſe rich minerals, and does not permit them to look after inferior ones. And in the *Eaſt-Indies*, where moſt gems are produced in greateſt perfection, they are ſtrangely ignorant in the manner of digging mines. To this we may add, that gems are often found in the metalline veins themſelves, or very near them; and I can produce ſeveral amethyſts that a gentleman of my acquaintance took out of a piece of ground abounding with the ores of iron and tin; the latter of which was there dug up in plenty. And in colder countries, ſuch as *Germany* and *England*, where hard gems are more rare, the ſoft ones that mineraliſts call *Fluores*, are often to be found in or near metalline veins, ſo finely tinged by mineral juices, that were it not for their ſoftneſs, they might paſs for emeralds, rubies, ſapphires, *&c.* as I learn from mineral writers of good credit, from eye-witneſſes, and partly from my own obſervation.

(5.) But further to the ſame purpoſe, it ſeems poſſible to obtain from ſome gems, by menſtrua, tinctures, that ſeem rather extractions, than proper diſſolutions. I once made a menſtruum, which being poured upon well-colour'd granats, not calcined, but entire, was thereby ſoon beautified with a high and lovely tincture, admired by very skilful perſons to whom I ſhewed it, becauſe the menſtruum was not more corroſive than white-wine; yet I took this to be a genuine tincture, becauſe it was drawn in the cold, becauſe the liquor would not tinge it ſelf by ſtanding alone; and laſtly, becauſe it drew a tincture from antimony of a very different colour from that we ſpeak of. Nor are granats the only gems which I have made this liquor work upon, without heat.

(6.) Suſpecting, for ſeveral reaſons, that ſome granats contain, beſides other metalline ſubſtances, many corpuſcles of a ferruginous nature, I made choice of ſome ſmall ones, which by their deep and almoſt dark colour, I gueſſed participated largely of iron or ſteel, and applied them to a vigorous loadſtone, which, as I expected, readily took them up; and hereto they conſtantly adhered till they were forcibly

cibly ſeparated therefrom. But tho' I tried this upon ſome parcels of granats, yet I found there were not many in one heap that would eaſily adhere to the magnet.

(7.) Some gems, which jewellers without ſcruple, affirm to be rubies, ſapphires, *&c.* are either colourleſs, or have other colours than thoſe which uſually belong to them. The famous goldſmith *Benvenuto Cellini* ſays, there is one kind of rubies naturally white, which he proves by the degree of hardneſs peculiar to rubies. And the ſame author mentions white berils, topazes, and amethyſts; and, by his account, the *Italian* jewellers think not the tinctures of gems any thing near ſo eſſential to them as we commonly repute; ſince they reckon topazes and ſapphires, whereof one is blue, and the other yellow, but both extremely hard in compariſon of all other gems, except diamonds, to be of the ſame ſpecies. The degree of hardneſs in rubies and ſapphires is often ſo equal, that I knew an expert *Engliſh* jeweller, who for that only reaſon took them to be the ſame kind of ſtone.

And that gems, referr'd by lapidaries to the ſame kind, may be very differingly tinged, is a truth whereof I have ſeen notable inſtances in diamonds themſelves; which I therefore prefer to other examples, becauſe the extreme hardneſs of diamonds is what keeps jewellers from miſtaking any other ſtone for them; if they may be allow'd to try them on the wheel employed to cut them. Now of true diamonds I have ſeen ſome that were yellowiſh, others more yellow, and among the reſt, one that was ſo perfectly yellow, that I at firſt took it for a fair topaz, tho' it was valued at near three pound weight of gold. I have alſo ſeen rough diamonds, as they came directly out of the *Indies*, which were either bluiſh or greeniſh, and one particularly which was ſo green, that if its ſhape, *&c.* had not convinc'd me of the contrary, I ſhould have taken it for an emerald.

I once purchaſed a conſiderable number of ſmall rubies, many of which were very curiouſly ſhap'd; and coming to look upon the whole parcel more leiſurely, I found one colourleſs, but in other reſpects ſo like the reſt, that I conjectured it of the ſame kind, only coagulated and hardened before the mineral pigment had tinged it of the colour of the reſt. And I was confirm'd in my gueſs by a gentleman, who had been in the chief places of the *Eaſt-Indies*, where rubies are found, and particularly at the river of *Siam* or *Pegu*, where he frequently ſaw theſe ſtones taken from the bottom of the water, and, ſometimes, took them out himſelf. This gentleman aſſured me, he had there ſeen ſeveral ſtones, each of which was partly a ruby and partly colourleſs; and that, ſometimes, in the ſame ſtone there would be two portions of one ſort, and a third, lying betwixt them, of another; which has frequently oblig'd the jewellers conſiderably to leſſen the bulk of ſuch ſtones, by cutting off the untinged part. And if my memory does not much deceive me, I ſaw, in a curious prince's cabinet, a ring ſet with a ſtone of a moderate bigneſs, whereof only about one half was well tinged, while the other remained colourleſs. In gems that are leſs precious, and not ſo tranſparent, eſpecially in agate and opake ſtones, I could eaſily give a multitude of inſtances of the ſame entire ſtone being differently tinged in ſeveral parts; and I uſually wear, in a ring, a ſmall ſardonyx, wherein there are three portions, one within another; the uppermoſt whereof is black, the middle a kind of cheſnut colour, the other blue, almoſt like a turquoiſe; each of which portions is exactly of a fine oval figure, and each of the two outermoſt of a very uniform breadth and colour throughout, and exactly parallel to the other. And to inſtance in tranſparent ſtones, 'tis known, that jewellers reckon, among ſapphires, not only that ſort of azure ſtones which uſually paſs under that name, but alſo another kind, becauſe of their ſapphirine hardneſs; tho' for their want of tincture they call them white ſapphires.

(8.) We ſometimes ſee gems partly tinged, and partly not, in ſuch a manner as if the pigment, mixing with one portion of the matter, whereof the ſtone conſiſted whilſt it was liquid or ſoft, were not able to diffuſe it ſelf thro' the whole, nor to give an equally intenſe colour to all the portions it tinges. 'Tis true, in ſome caſes the diffuſion may be ſtopped by the petreſcent juices firſt coagulating in a part where the tincture was not mixed; and perhaps in others, the different colours may have belong'd to different portions of matter coagulating upon or againſt each other, at different times, yet ſo as to ſeem one entire ſtone; but which ſoever of theſe explications be admitted, it will confirm our hypotheſis, that the origin of gems is from a fluid or ſoft material. I have in ſome hard ſemi-diaphanous ſtones, as well *European* as *Eaſt-Indian*, obſerved a very irregular and unequal diffuſion of tincture. And in *Italy*, I have ſeen a large piece of cryſtal, whereof the pyramidal part was of a tranſparent green, whilſt the vertex appeared richly tinged like an emerald; but the farther the colour ſpread from thence, the fainter and paler it grew; ſo that before it came near the baſe, it was quite ſpent, and left the larger part of the ſtone tranſparent and colourleſs, like ordinary cryſtal. And hence, perhaps, we may explain the meaning of *Joſephus Acoſta*, where he ſays, that emeralds grow in ſtones like cryſtal; that he had ſeen them in the ſame ſtone faſhion'd like a vein; and that they ſeem, gradually to thicken and refine. And this learned author has a memorable obſervation, that may confirm both what I have juſt now related, and what we mentioned a little above about colourleſs gems: "I have ſeen, ſays he, ſome that were half white "and half green; others all white, ſome green, and very perfect."

To conclude, I have given to pieces of rock-cryſtal, tolerably good tinctures by mineral fumes; and ſuppoſing the pieces, thus coloured, to be entire ſtones, as they generally appeared to be, the inſtance will be pertinent to our purpoſe; for tho' the colours thus given, do not uſually penetrate very deep, and are aſſiſted by no faint degree of heat; yet, on the other ſide, theſe cryſtals had attained their full hardneſs, and, after their colouration, were cut and poliſh'd like others; whilſt the gems we mean, are ſuppoſed to have been tinged under ground, when they were yet fluid, or at leaſt ſoft. That there are ſometimes generated in the bowels of the earth, mineral exhalations, capable of applying themſelves to the ſtones they meet with there, is certain; and that alſo ſome hard and ſtony ſubſtances have been actually tinged by ſuch mineral ſteams, I ſhall hereafter ſhew. I remember too, even in ſo hard a gem as a ſapphire, to have obſerved the efficacy of theſe ſubterraneal fumes; for I have often ſeen one of thoſe ſtones, wherein a fine ſeal was cut, which continued ſo oddly tinged, notwithſtanding what had been taken off to reduce it to an exquiſite ſhape, that a skilful perſon of my acquaintance, by whom it had been engraven, aſſured me, that he found it of the full hardneſs of a ſapphire, and that the mineral fumes had ſo ſtained it, that, in his opinion, it might, by the look, paſs for a chalcedonian.

Heterogeneous matter having been found in their ſubſtance.

5*thly*, Solid gems may include heterogeneous matter in them. Several inſtances of this ſort I have ſeen in opake ſtones; but in tranſparent ones they are very great rarities; and therefore it will not, I preſume, be thought ſtrange, if I mention but a few. Firſt then, a very ingenious lady, who had accompanied her husband in an embaſſy to a great monarch, aſſured me, that ſhe brought back with her a piece of cryſtal, in the middle whereof there was a drop of water, that by its motion might be very eaſily obſerved; eſpecially when the cryſtal was made to change its poſture; and I have in ſome pieces of rock-cryſtal obſerv'd particulars, which ſeemed to argue, that ſomewhat or other was intercepted in the body of the ſtone.

A curious perſon who traded in *Indian* gems, particularly in grizolets, averr'd to me, that among ſeveral rough ones brought from the *Indies*, he had ſeen one that was about the bigneſs of a filberd; in the ſolid ſubſtance whereof there was a cavity, with a certain liquor in it, which, by changing the poſture of the ſtone, might be made to move to and fro. And when the drop was ſettled, it was of the bigneſs of a round pearl, that he ſhewed me, which wanted ſomewhat of a moderate ſize for a necklace; he added, that this rarity cauſed the ſtone, which was otherwiſe of ſmall value, to be priz'd at an hundred pounds. And I have my ſelf ſeen a monſtrous gem, which was little leſs a rarity than the former. And what renders this account of the grizolet the more probable, having broken a ſtone, that was brought as a rarity from the *Eaſt-Indies*, where gems are often harbour'd in ſuch ſtones, I found in the ſolid ſubſtance of it, which was ſo hard as to ſtrike fire like a flint, and in its little flakes was at leaſt ſemi-diaphanous, a cavity, wherein were coagulated very minute, poliſhed, cryſtalline ſtones, that ſeemed to have their points inwards; which argued there had been ſome liquor there, wherein theſe glittering particles had ſhot, tho' in proceſs of time, the remaining and incoagulable part of it might have been imbibed by the ambient matter, if not have eſcaped thorough it, by virtue of ſome peculiar congruity of it with the pores of the ſtone; which need not be thought impoſſible, ſince experience has aſſured us, that ſome ſolid ſtones, and even gems, may be penetrated, or have their texture altered by common water. Nor are theſe the only heterogeneous ſubſtances I found included in this ſtone.

Amber, which is reckon'd among gems, and ſometimes proves exceeding hard, affords a great confirmation, or at leaſt an illuſtration of what I have been ſaying; for I have now by me a fine piece of that ſubſtance clear and ſolid, wherein is included a large entire fly, in ſhape and ſize much like a graſhopper, but variouſly and curiouſly colour'd, with his wings diſplay'd.

To theſe obſervations I ſhall add, that I have poſſeſs'd one of thoſe pale amethyſts, which ſome call white, wherewith I cou'd readily cut glaſs; yet in the body of this ſtone there appeared to be a conſiderable number of things that look'd exactly like hairs, ſome of them lying parallel, and others inclining to one another; and upon viewing them, both by the light of the ſun, and that of a candle, in various poſitions, ſome of them ſeemed at times to be of a lovely reddiſh colour, but reflected the light, as if they were well filled either with air or water; tho' for the moſt part they ſeemed of a browniſh colour, which made the ſtone not a little admired. And a gentleman, eminent for his travels into the *Eaſtern* parts, and for his skill in jewels, told me, that he had ſeen a white ſapphire, a table-ſtone, about the middle whereof appeared a cavity, large as a pin's head, or a ſmall vetch, containing a drop of liquor, that it ſeems cou'd not be coagulated into ſtone with the reſt of the matter. This liquor, he ſaid, was very eaſily diſcernible, by ſhifting its place in the cavity, as the ſtone was put into different poſtures. He farther aſſured me, there was no flaw in the ſtone, at which the liquor might be ſuſpected to have entered, but that the cavity appeared every way encompaſſed by the ſolid ſtone, and lay about the thickneſs of three barly-corns, below the upper ſurface of it. And, indeed, I have ſometimes ſuſpected, that even in diamonds themſelves there may poſſibly be intercepted, or mixed with the pure petreſcent ſubſtance, particles of heterogeneous matter; and in this ſuſpicion I was a little confirmed, by the odd clouds I had obſerved in an extraordinary diamond, and by hydroſtatical, and other obſervations, made upon ſuch ſtones; ſome of which proved heavier than either cryſtal, or white marble. And, likewiſe, an ancient diamond-cutter of great experience aſſured me, he had obſerved a ſenſible difference of weight among diamonds of the ſame growth, eſpecially in thoſe that were cloudy or foul; and that he ſometimes found in diamonds of the bigneſs of two peas, it amounted to about a carret, which is by common eſtimation four grains.

6thly, The laſt argument I ſhall produce to ſhew, that the matter of ſeveral gems may have been once fluid, ariſes from the proofs of the ſecond part of our hypotheſis; for if it ſhall appear, that many tranſparent gems have metalline, or other extraneous mineral bodies, intimately mingled with their ſmalleſt particles, it will be very reaſonable to ſuppoſe, that ſuch a mixture was made, when the bodies were in a fluid form; how elſe ſhould the metalline corpuſcles be convey'd into ſuch compact and hard bodies as gems? But if our hypotheſis be admitted, 'tis eaſie to apprehend how among bodies ſo entirely different as metals and ſtones, ſuch exquiſite mixtures may be made, as are required to give an uniform colour, tranſparency, and figure to them.

And metalline, or mineral bodies mixed with their ſmalleſt particles.

To ſtrengthen the preceding circumſtances, I ſhall add the teſtimony of a late *French* author, who wrote about the method of eſtimating gems, according to the rates of modern jewellers. This curious gentleman gives us, from the mouth of the late famous travellers he converſed with in ſeveral parts, an account of the number and names of the places where diamonds and rubies are found in the *Indies*; adding ſome circumſtances and particularities about the quality of the ſoil in thoſe places, that I have not elſewhere met with. Speaking of the firſt of thoſe three diamond mines, which he takes to be the only ones in the *Eaſt-Indies*, after having told us, that the ſtones are there found ſome in the ground, and ſome in the rock, he adds, that thoſe drawn from the rock, or the neighbouring parts, have commonly a good water; but for thoſe which are drawn out of the ground, their water partakes of the colour or ſoil wherein they are found; ſo that if the earth be clean, and ſomewhat ſandy, the diamonds will be of a good water; but if fat, black, *&c.* they will have ſome tincture thereof: nay, he immediately annexes, that if there be ſome black or red ſand among the earth, the diamond will alſo retain ſome grain of it. And mentioning the ſecond mine of diamonds, he declares, that here, as in the former, the ſtones partake of the quality of the ſoil; ſo that if that be boggy or moiſt, the ſtone will incline to blackneſs; and if reddiſh, 'twill have an eye of that colour. He alſo tells us, that of late there were found in the kingdom of *Golconda*, ſtore of diamonds; which being brought to the firſt miniſter of ſtate, he forbad all further ſearch after them, becauſe not one in the whole number had a good water; the whole parcel being either black or yellow.

Whether gems are faſhion'd by ſome ſeminal or plaſtic power?

Before we proceed further, 'tis proper in this place to take notice of a conſiderable objection that may be offer'd, againſt the doctrine hitherto deliver'd. This objection is taken from the configuration of ſome gems, and eſpecially the priſmatical one of cryſtal, whereof we have given ſeveral inſtances. For it ſeems ſcarce poſſible, that ſo curious a ſhape ſhou'd be ſo uniformly produced, in ſuch a multitude of cryſtals, great and ſmall, unleſs there were ſome ſeminal and plaſtic power to faſhion their matter in a regular and geometrical manner.

But he who ſhall attentively conſider the figuration of ſalts, and of metalline and other magiſteries diſſolved and coagulated with them, may be thereby greatly aſſiſted to diſcover the invalidity of this ob-

objection; but becauſe ’tis very ſpecious and important, I ſhall examine it a little more particularly.

And firſt, there is no abſurdity to ſuppoſe, that if there be a ſeminal and plaſtic power in mineral bodies, it may be harbour’d in liquid principles as well as others; for we ſee that the ſeed of animals, which often, as in the elephant, the rhinoceros, *&c.* produces hard ſolid bones, teeth, and horns, is at firſt but a liquid ſubſtance; and the forming power in ſome trees and their fruits, converts the alimental juice into wood, ſhells, and other very ſolid, and ponderous bodies.

Secondly, in accounting for the figures of alum, vitriol, and other ſalts, that are curiouſly and geometrically ſhaped, there is no neceſſity to introduce a diſtinct, architectonic principle; ſince thoſe bodies may receive their ſhapes from the coalition of ſuch ſingly inviſible corpuſcles, as by the motion of the fluid, wherein they floated, and other aſſiſtant circumſtances, are determined to ſtick together, rather in that manner than another. Thus a ſalt made from common ſalt, by the ſingle aſſiſtance of oil of ſulphur, or of vitriol and water, tho’ manifeſtly a factitious body, wherein the ſea-ſalt has its own nature deſtroyed, yet by reaſon of the figure of the reſulting corpuſcles, and their fitneſs to convene, when diſſolved in water, into curiouſly ſhap’d bodies, will, when rightly prepared, often ſhoot into long cryſtals, with points like diamonds, reſembling native cryſtal as well in regularity of ſhape, as tranſparency of ſubſtance. And that ’twas partly the figure produced by the operation of the oil of vitriol upon the ſea-ſalt, and partly other circumſtances, that determined the ſhape of the cryſtals, appears from hence, that when the quality or proportion of the oil of vitriol, was different from what it ſhould have been, or any error was committed in ſome part of the operation, the ſaline concretions, tho’ they did not ſhoot at all like cubes, as the ſea-ſalt, which they were made of, wou’d alone have done; yet they ſhot very unlike rock-cryſtal, tho’ into cryſtals for the moſt part very finely and differently figured. And that the natural figure of the ſea-ſalt is no way neceſſary to ſuch configurations, is manifeſt from this experiment. I took ſome ſtony *Striæ*, found in caves and grotto’s, whoſe petreſcent liquors coagulate, before they have time to fall down; and having diſſolved them in ſpirit of verdigreaſe, I put the clear ſolution to evaporate in a digeſtive furnace, after the ordinary manner; by which means, tho’ I made the experiment more than once, I had rather a coagulated maſs, than any thing like cryſtals; whence it appears, that a conjunction of ſeveral circumſtances may be requiſite to determine the figuration of conſiſtent bodies made out of fluids; ſince here, for want of time to make occurſions enow for the particles to concrete after the moſt convenient manner, the experiment ſucceeded not. Upon allowing many days to another ſolution of the *Striæ*, made in the ſame menſtruum, there ſhot about the ſides and bottom of the glaſs a number of diſtinct cryſtals, long, tranſparent, and curiouſly ſhaped.

Perhaps 'twill be ſaid, that the petreſcent juice, when broken, often appears to abound on the inſide with narrow ſtreaks like thoſe of antimony; and that I my ſelf have obſerved ſome gems to be made up of thin plates; which internal figuration ſeems much more difficult to be accounted for, without a plaſtic form, than the external.

But, for ought I find, many known ſalts wou'd, when broken, appear to be geometrically figured, even in their leſſer corpuſcles, as well as in their entire bulk; if we had eyes ſharp enough to diſcern the ſhapes of the minute, as well as of the larger bodies. And we have great inducement to think, that the ſmall viſible concretions, of which the bigger grains of ſalt conſiſt, are as well as the greater, of a cubical figure. Beſides, there are ſeveral bodies ſo luckily ſhap'd, that upon a ſlow coalition, they will convene into a multitude of manifeſt concretions; ſome of which conſiſt of ſtreaks, and ſome of flakes. Thus in the common ſal-armoniac, tho' confeſſedly a factitious body, upon breaking the bigger maſſes, great multitudes of ſtreaks are obſervable, like thoſe we uſually find in the broken *Striæ* of petrifying water. And I have prepared concretions, ſome of which conſiſted of ſalts alone, and others of ſalts and minerals, ſuch as ſtones or antimony, which look'd very like talc, being white bodies made up of a multitude of very ſlender ſtreaky particles, lying lengthwiſe one upon another. And as I have taken out of the earth many concretions, outwardly ſhap'd like a rhombus, and compos'd of a multitude of flat and extremely thin plates; ſo have I ſometimes imitated ſuch concretions by art. And tho' a ſolution of ſilver in purified *Aqua fortis*, uſually affords only a great company of ſmall, thin, and ſeemingly ſimple flakes, like ſcales of fiſh; yet having diſſolv'd a large quantity of the metal together, and ſuffer'd it to ſhoot leiſurely, and with due circumſtances, I obtained many cryſtals, which were geometrically figured without; and conſiſted of a multitude of exceeding thin flakes, orderly adhering to one another. And for a yet more pregnant experiment, to clear this objection; tin-glaſs, tho' a compact and ponderous body, conſiſts of many ſhining, poliſh'd flakes; yet, I found, that if this mineral were melted, and ſuffer'd to cool of it ſelf, the diſpoſition of its component particles wou'd determine them to ſtick to one another in broad ſhining flakes; whereof many will lie upon the reſt, and ſome acroſs each other, at various angles, according as the matter happen'd in its ſeveral portions to be refrigerated. There are factitious bodies alſo, which afford us the like inſtances; as I have obſerved in mixtures of copper, iron, and other minerals; and very conſpicuouſly in good *Regulus martis ſtellatus*, whoſe internal parts may be found, by breaking it, to conſiſt of flat, ſhining, poliſh'd flakes.

If it be urg'd, to ſtrengthen the foregoing objection, that ſome petreſcent juices concrete, even whilſt men are looking on; and yet our ſtony *Striæ* have in ſome places a ſtreaky, and in others an angular configuration of parts; I anſwer firſt, that I have ſeen ſeveral concretions of that kind, which, as far as appear'd to the eye, were made up of parts confuſedly jumbled together. And, ſecondly, I have found by trials, that if there be a due diſpoſition in the component corpuſcles of bodies to ſuch configurations, they may be brought to concrete accordingly, in a far ſhorter time than one wou'd imagine. Having ſometimes warm'd ſix or ſeven ounces of *Aqua fortis*, glutted with fine ſilver, till the mixture was wholly brought into a tranſparent liquor; and then put the clear, ſtrong glaſs which contain'd it into cold water, that the menſtruum might be the more haſtily refrigerated; I obſerved, that when once the diſſolv'd metal began to ſhoot, the coagulation into figur'd cryſtals proceeded ſo faſt, that the naked eye cou'd ſee its progreſs. And having ſometimes put a quantity of ſalt and ſnow, or ſome other ſtrongly refrigerating mixture, into a convenient glaſs, and wetted the outſide with a ſtrong ſolution of ſal-armoniac, or ſome urinous ſpirit, whereby, tho' it wou'd be coagulated in leſs than a minute; yet the ſalt into which it ſhot had uſually a curious and determinate figure, according to the nature of the liquor that afforded it; as I have often experienced.

Perhaps you will ſay, theſe inſtances are taken from ſaline bodies, which are, for the moſt part, diſpoſed to convene into ſmooth ſurfaces, and angular ſhapes, and to be eaſily wrought on by the external cold; and that it may yet ſeem ſtrange, what in ſome caſes muſt have happened, if our hypotheſis be admitted, that external circumſtances and accidents, ſuch as the figure of a mould, or womb, the coldneſs of the ambient medium, *&c.* ſhould viſibly, and ſometimes greatly diverſify even the internal figuration of cloſe and ſolid minerals and gems; without excluding all thoſe that are ſuppoſed to be of a quicker concretion.

To clear this difficulty, I ſhall ſubjoin an experiment, deviſed to ſhew, that if the corpuſcles of a body be ſo ſhap'd, as to be fitted, by their coalition, to conſtitute ſmooth, gloſſy planes, tho' they be variouſly ſhuffled and diſcompoſed as to their priſtine order; yet if kept for a while in a ſtate of fluidity, they will preſently convene again into ſmooth, ſhining planes; and the ſituation of thoſe planes, with reſpect to one another, will be exceeding uniform and regular, conſidering the concretion is haſtily made; while their internal contexture will be much diverſify'd by circumſtances, as particularly, by the figure of the veſſel or mould, wherein the fluid matter concretes. Conſidering then, that if, as was lately obſerved, we break the lumps of tin-glaſs, it will diſcover a great many bright and ſmooth planes, which ſometimes meet, and ſometimes croſs one another, at very different angles; I thought it probable, that a body which had been melted, and was apt to convene into ſuch planes, wou'd not only do the ſame upon a ſecond fuſion, but might have the order and magnitude of theſe planes

Nat.Hist. diverſified by the figure and capacity of the veſſel, choſen for the purpoſe. Having, therefore, powder'd a ſufficient quantity of tin-glaſs, when 'twas well melted, and caſt it into a good pair of iron moulds, whoſe cavity was an inch in diameter, we thence obtained a bullet, which, being warily broken, ſeem'd, as we expected, to be made up of a multitude of little ſhining planes, ſo ſhap'd and placed, that they appeared orderly to decreaſe, as they were further removed from the ſuperficies of the globe; they were, likewiſe, ſo rang'd as to ſeem made up of a multitude of theſe rows of planes, reaching every way, almoſt like ſo many *radij* of a ſphere, from the center to the circumference. But if tin-glaſs be melted in a crucible, and ſuffer'd to cool there, the matter, when taken out and broken, will appear, indeed, full of ſmooth planes, but, as was lately intimated, very irregularly and confuſedly aſſociated or ranged.

This experiment we have, alſo, varied by caſting bullets of ſome other bodies, and particularly of the ſimple regulus of antimony, and with ſucceſs; tho' the texture hereby produced was not ſo uniform as in tin-glaſs. And by caſting melted ſulphur into a ſpherical body of about five or ſix inches diameter, and breaking it warily; tho' one wou'd think this an unlikely mineral to make any other than a confuſed concretion; it preſented us great fibres almoſt like little ſtraws; whoſe number and orderly ſituation afforded a conſiderable inſtance for my preſent purpoſe.

And having broken ſeveral marcaſites of a peculiar ſort, that were either roundiſh or almoſt of a cylindrical figure, to obſerve their internal ſtructure and qualifications; I found in ſome of them a great many rows of little planes, or glittering corpuſcles, reaching from the innermoſt parts to the external ſurface, and in thoſe that were cylindrical, to the outſide. Theſe ranks of gold colour'd particles, in the ſeveral planes of the broken mineral, ſeemed like ſemi-diameters, iſſuing from a row of phyſical points of an imaginary line, lying almoſt like the axis of a cylinder; as if the cavities of the chalk or clay, where theſe marcaſites were found, had made the ſoil like a mould, wherein the matter of them being detained, whilſt 'twas in a fluid form, afterwards concreted like the bullets of our tin-glaſs, &c.

As to the uniformity of ſhape admir'd in gems, and which is thought to demonſtrate them to be form'd by a ſeminal and geometrical principle; I cannot find, upon a more attentive ſurvey, that it is near ſo great as men uſually imagine.

In ſeveral tranſparent gems it manifeſtly appears, as I lately noted, that the ſhape was, in a great meaſure, owing to the figure of the womb or mould, wherein the matter, whilſt liquid or ſoft, happened to ſettle. But in ſome other tranſparent and well figured gems, of the ſame denomination, and, ſometimes, growing very near one another, I have found, by a diligent inſpection, a manifeſt, and ſometimes a very conſiderable difference of ſhape, either as to the number, figures,

gures, or bigneſs of the ſides that made it; by comparing theſe particulars with thoſe of a ſtone of the ſame kind perfectly figured. This I took notice of particularly, in two ſorts of ſtones, granats, and *Corniſh* diamonds. A conſiderable number of the former, that grew in *America*, was brought to me in one lump of matter; but growing in diſtinct parts of it, and without touching one another. Among theſe I took notice of a manifeſt diſparity of ſhape; ſo I did in ſome *African* ones, as alſo in others that were *European*; one of which, being of an extraordinary large ſize for a figured gem of the tranſparent kind, and weighing above eleven drams and a half, I conſider'd, with a particular attention; and found, that tho' it ſeemed to have been coagulated in a fluid medium, and to conſiſt of twelve planes, at the concourſe of two or three whereof it ſeem'd to have been broken off from the root; yet it was very far from the geometrical dodecahedron; for as this conſiſts of twelve equilateral and equiangled pentagons, almoſt all the planes of our granats were quadrilateral, and very different from what they ſhould regularly have been, not only in magnitude, but in ſhape; for one of them ſeemed to have five ſides; and for the reſt, ſome were neareſt to a rhombus, others to a rhomboides; but the moſt were trepezia. And, by the way, a curious perſon ſhewed me a pearl very irregularly ſhaped, and of an enormous ſize. It was ſo artificially ſet in gold, that by the help of a little of that metal, fitly placed, the whole jewel repreſented a lion; yet I made a ſhift to meaſure it exactly with collapar compaſſes, and found the length to be an inch and a half, and the greateſt breadth, where it was of a proportionable thickneſs, to be $\frac{4}{5}$ inch. The colour was orient enough, except one dark ſpot, which by its ſize, figure, and ſituation, I gueſſed to be the remains of that part whereby 'twas faſten'd to the ſhell of the fiſh which produced it. And thus much for the firſt ſort of gems, whoſe figures I obſerv'd to be irregular.

The ſecond conſiſts of thoſe cryſtalline ſtones, ſome of which are much harder than the *Briſtol* diamonds, or, perhaps, than rock-cryſtal it ſelf; for 'tis eaſie to write upon glaſs with them. Having procured a large number of theſe ſtones, I took notice, by comparing them together, that tho' ſome of them were geometrically and curiouſly ſhap'd like rock-cryſtal, having each ſix ſides, whereof two, that were oppoſite, ſeem'd perfectly alike and equal; and tho' the ſtone had a pyramidal termination, made up by ſeveral reſembling and curiouſly figur'd planes, that ended in a ſolid angle; yet the greateſt number, by much, of theſe diamonds, conſiſted of ſtones whoſe figures were far from exact and uniform. For tho' moſt of them had ſix long planes, yet often the oppoſite ones were neither parallel to one another, nor ſimilar, but exceedingly unequal; and thoſe planes that went to make up the apex, compared with one another, or with regular patterns, their figures, magnitudes, and manner of concurring, were ſo remote from uniform, as to agree far better with our hypotheſis than with the other. And yet the want of room to coagulate freely, could not, with probability, be here pretended; for they ſeem'd to have been form'd ſeparately in a fluid ambient, except at the bottom, where they were faſtened to the rock; as appeared by an opake root which ſtill adhered to moſt of them. And, if I miſremember not, I have more than once, on diamonds newly brought from the *Indies*, and ſome of them very fair ones, obſerved great irregularities in the area's of the ſuperficial planes, or in their figures, or both; and, ſometimes, in the very number as well as ſituation of their ſolid angles.

I now proceed to ſhew, that the figuration of gems not only conſiſts with our conjectures, but confirms them; for I have, more than once, taken notice in *Corniſh* diamonds, that a ſmall ſtone, of the ſame kind, has made, as it were, one body with a greater; not only adhering cloſely to it, but being bedded in it; ſo that when they were ſeparated, there remained a cavity in the larger, whoſe figure exactly anſwered that of as much of the ſmaller ſtone as chanc'd to be lodg'd therein. Thus, alſo, I have ſeen a greater grow to a much leſs; there being a cavity in the latter anſwerable to the part of the greater that had enter'd it; which ſeems to ſhew, that the ſtone to which the other grew, was firſt form'd and hardened, ſince it retain'd its own ſhape; and that whilſt this adhered to the rock or ſoil, more liquor began to coagulate, by faſtening it ſelf to the ſolid body, which was already concreted. Thus by putting into a ſtrong ſolution of pure nitre, or rock-alum, ſome little ſticks of wood or other ſolid body, that may be kept ſteadily in the ſame poſture, you will ſee many coagulations begin to be made againſt them; and the cryſtals, thus concreted, will neceſſarily have their figures incompleat, and cavities correſpondent to thoſe parts of the ſtick whereto the ſaline corpuſcles faſtened. And tho' I inſtance this inoſculation of figured ſtones but in *Corniſh* diamonds, yet thoſe are not the only tranſparent minerals wherein I have obſerved it. And particularly, I found among a parcel of minerals, a fine tranſparent and neatly figured ſtone, which ſeem'd to be pure cryſtal; but lay coagulated about a kind of branching wire, whereof a great part was encloſed by the ſtone, ſeem'd to grow out of a piece of ore, reſembling that of ſilver; which the owner affirmed to be, together with the above mentioned branch, good ſilver, produced by nature in that form; which excellently agrees with the reſemblance I juſt propoſed, betwixt the coagulation of diſſolved ſalts and the liquid matter of gems, about ſtable bodies immerſed therein.

A greater ſpecific gravity in gems argues their metalline or mineral nature.

But to proceed. The ſecond grand conſideration, whereon our hypotheſis is founded, ariſes from the weight of ſome gems, which, being greater than what ſeems to belong to them, as hard tranſparent ſtones, we may, probably, derive it from metalline or mineral mixtures. Gems are eſtimated by lapidaries as they weigh a determinate number of carrats, or of grains; for they compare only the weight of ſtones, of the ſame kind, to one another, as the greater or leſſer weight argues a greater or leſs bulk; without regarding the ſpecific gravity of them, which depends not on their magnitude.

Now rock-cryſtal, as it is by mineraliſts reckon'd among gems, ſo it is hard enough, as I have tried, both to cut glaſs and to ſtrike fire; and its having ſo great a tranſparency, and wanting colour, makes it exceeding likely to be free from adventitious mixtures. I therefore pitched upon it as the ſtandard whereby to make a probable eſtimate of the weight of gems; and having hydroſtatically examined it, firſt in the air, and then in water, I found its weight to an equal bulk of the latter fluid, as two and almoſt two thirds to one; which, by the way, ſhews us how groundleſly many learned men ſuppoſe cryſtal to be ice extraordinarily hardened by a long and vehement cold; for ice is bulk for bulk, lighter than water; and *Madagaſcar*, as well as other countries in the torrid zone, abounds with cryſtal.

Having thus found the weight of cryſtal to water, when I met with a coloured gem, whoſe ſpecific gravity I gueſſed to be ſenſibly greater than of that, I ſometimes weighed them in the air, and in the water, and ſo diſcovered whether I had conjectured right. And if the ſpecific gravity of the gem much exceeded that of cryſtal, I thought it probable there might be ſome metalline or mineral corpuſcles mingled with the ſtony ones thereof, whence it might alſo, probably, derive its tincture. Finding ſome *American* granats, which I had a great and peculiar reaſon to believe had once been liquid, of a colour ſo deep, that they were almoſt opake; and judging, likewiſe, by my hand, that they were much heavier than pieces of cryſtal, of the ſame bulk, I weigh'd them in a pair of nice ſcales in air, and in water, and found, as I expected, that they were almoſt four times ſpecifically heavier than that fluid; and, conſequently, heavier by about a third part, than pieces of cryſtal of the ſame bigneſs. But we muſt obſerve, tho' when colour'd gems have a greater gravity than cryſtal, 'tis probable ſome metalline pigment, or other mineral ſubſtance, may be mixed with them; yet if ſuch gems have no ſuch additional weight, it will not follow, that their colour cannot proceed from any mineral tincture; ſince a mineral ſubſtance may be preſent in a liquor even when it adds no manifeſt weight thereto. Thus I have found a mineral water, which, by its taſt, its effects, and the colour it would ſtrike, appeared to be richly impregnated with iron; yet being carefully examined hydroſtatically, it ſeem'd very little, if at all heavier than common water.

Metals and minerals may be extracted from gems.

The laſt argument I ſhall now make uſe of is, that out of ſeveral medicinal ſtones, and even out of ſome fine gems, real and corporeal metals, or other mineral ſubſtances, may be extracted. But as the further proſecution of this argument will be more proper hereafter, with regard to opake gems, where its force will beſt appear; I ſhall but lightly touch upon it in this place. To ſhew, however, that it affects gems as well as opake ſtones, I obſerve firſt, that ſeveral ſtones reckoned amongſt precious ones, are opake; as the turquoiſe, the onyx,

the

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And there is no doubt, that the experiments, whereby I have obtained mineral or metalline ſubſtances from load-ſtones, native cinnabar, blood-ſtones, *&c.* might alſo ſucceed in ſeveral of the more ponderous gems; if their glaſſy nature, or the exceeding compactneſs of many of them, rendered not the mineral corpuſcles harbour'd in the ſtony, or inſoluble parts, inacceſſible to the common menſtrua. And when the metalline and mineral ingredient is in great plenty, and the tincture of the ſtony parts not very cloſe; I queſtion not but even from tranſparent gems, the adventitious ingredient may in part be diſſolved: for having by the weight of the granats lately mentioned, concluded them impregnated with ſomewhat metalline; I kept ſome of them in a crucible for a competent time in the fire, and found they thereby exchanged their colour for one not unlike that of rough iron. And having reduced them to a very fine powder, and digeſted ſome acid menſtrua, and particularly rectified ſpirit of ſalt upon them, they afforded me a rich tincture. Encouraged by this, I hoped, that without being previouſly burnt, they wou'd in *Aqua regia* afford a tincture; and accordingly I obtain'd from crude granats, (reduced to very fine powder) a rich ſolution, which tho' in colour it ſomewhat reſembled a ſolution of gold; yet partly by the colour of the burnt granats, and partly by the taſt of this ſolution, I ſuppoſed that another metal was more likely than gold, to be predominant therein. And having gently evaporated part of that menſtruum, I obtained from ſome of the remainder certain cryſtals, whoſe ſhape, by reaſon of their ſmallneſs and diſorderly coagulation, I cou'd not well determine; but, touching the uncoagulated portion of the liquor with the tip of my finger, and adding that part of a drop which reſted thereon, to a great many drops of the infuſion of galls, it inſtantaneouſly turn'd them full as black as ink.

This trial I made to examine, whether one mineral, at leaſt, that helped to conſtitute theſe granats, was not of a feruginous nature; for if it were, I ſuppoſed, like other bodies that participate of iron, it would afford, with galls, an inky colour. A parcel, alſo, of ſmall red tranſparent ſtones, gueſſed by ſome to be granats, but by others, more probably, rubies, being finely powdered, gave, in an appropriated menſtruum, a colour like that of diſſolv'd gold; and that ſome parts of the gems were really diſſolv'd in the menſtruum, appear'd not only by the colour; but having put ſome of this liquor to a tincture of galls, it produced, at the very firſt, a dark colour, tho' not near ſo black as that of the former granats; and immediately let fall a copious precipitate, that was almoſt white. I, moreover, precipitated from it, by an urinous ſpirit, a reddiſh ſubſtance; which being ſuffer'd to dry in the air, ſeem'd to grow into bodies ſhap'd like moſs; and here and there ſmall muſhrooms, all of them prettily coloured. And from certain granats that were in ſome places opake, as well as in others diaphanous, I obtained a ſolution; the ſuperfluous liquor whereof being abſtracted, the reſidue, which was deeply coloured, did, in the cold, afford a kind of ſaline concretions; tho' not large enough to have their figures determined.

And, perhaps, if men had the curioſity to make trials, there wou'd be other tranſparent minerals found, capable to be wrought on by appropriated menſtrua. For I do not think that every ſeeming glaſſy contexture of a mineral, unfits it for that purpoſe. Tho' the clear ſpar, which, in moſt of our weſtern lead-mines in *England*, is found next to the metalline veins, be at leaſt ſemi-diaphanous, and of ſo glaſſy a texture, that it uſually breaks into ſmooth and gloſſy ſuperficies, appearing like a talc; and is, alſo, for the moſt part made up of geometrically figured bodies, reſembling in their ſurfaces, a rhombus, or rhomboides; yet ſome other experiments I had made with it, inducing me to ſuſpect, that 'twas not indeed a talc, but a body of a much more open texture, I found I cou'd diſſolve it in ſeveral liquors; and particularly in good ſpirit of ſalt, which wou'd preſently work upon it, even whilſt it remained in lumps; and that too without the aſſiſtance of heat.

But from what I have ſaid as to the uſefulneſs of menſtrua, it muſt not be inferr'd, that they are the only inſtruments wherewith ſomething metalline may be obtained from gems; for I have made conſiderable attempts of this kind by fuſions, and appropriated additions. And, however ſuch trials may ſucceed, as to the ſeparating from a gem, a metalline or mineral body of a determinate ſpecies, I have an eaſie way, in which, by the help of fuſion, I more than once manifeſted, in general, that there may be ſubſtances partaking of a metalline nature, in ſome kinds even of tranſparent gems; and partly by the ſame method, and partly by others, I have in ſome caſes determined, with probability, that mineral ſubſtance is here predominant.

It may ſerve to illuſtrate our hypotheſis, that having reduced to powder ſome *Striæ* of water, ſpontaneouſly petrified, diſſolved it in ſpirit of verdigreaſe, ſuffered ſome of it to evaporate, and put the reſt into a cool place; I obtained many ſmall, finely figured, and tranſparent cryſtals, that ſhot much after the faſhion of thoſe of the purer ſort of nitre. With ſome part, alſo, of this ſtony ſolution, I mixed, in a convenient proportion, a high-coloured ſolution of copper, made with the ſame ſpirit of verdigreaſe; and the two ſolutions being warily put together, did not precipitate one another, but afforded, upon the evaporation of their ſuperfluous moiſture, among many cryſtals, that were tranſparent and colourleſs, ſome that were richly adorned with a greeniſh blue tincture of the diſſolved metal.

SECT. II.

I Now proceed to thoſe conſiderations, which, aſſiſted by what has already been delivered, may ſuffice to ſhew our conjecture, as to the cauſe of the virtues of gems, to be rational.

Mineral productions exceeding numerous in the bowels of the earth.

My firſt obſervation is, that the earth not only contains a great number and variety of minerals, known by particular names, but very many others wherewith we are hitherto unacquainted. What a vaſt multitude of metalline ores, marcaſites of ſeveral ſorts, antimonies, tin-glaſs, *Fluores*, talcs of various kinds, ſpars, ſulphurs, ſalts, bitumens, *&c.* are mentioned by chymiſts and mineraliſts, in the accounts of repoſitories, and collections of natural rarities? Nay, the diligence of ſome modern writers hath reckoned up between two hundred, and two hundred and fifty foſſils of the ſame kind.

The ſecond part of our obſervation appears, from conſidering the very ſmall proportion that the perpendicular depth of the generality of mines, bears to the ſemi-diameter of the earth; ſo that tho' our globe were inhabited by ſome hundred millions of men more than now it is, and they had the curioſity to dig mines every where, their ſpades wou'd uſually penetrate ſo little a way into the earth, that a vaſt multitude of foſſils might, by lying deeper in the bowels of it, ſtill continue undiſcover'd. And, as far as I have obſerv'd, almoſt every region hath peculiar minerals, different from thoſe of other countries. Thus in ſome counties of *England*, a curious eye may, doubtleſs, obſerve ſeveral, that are unobſerved by the inhabitants themſelves; eſpecially if well contriv'd borers were diligently and ſkilfully employed to pierce the ground, and bring up ſamples of the various foſſils that lie hid under it. And this I can my ſelf ſay, in general, that in ſome parts of *England*, where I had more opportunity than in others, to exerciſe my curioſity about minerals; I have, in a ſmall compaſs of ground met with a much greater variety of them than I expected; many of which were deſcribed by no writer that I know of: and ſeveral of the like have been ſent me from different foreign countries.

Various menſtrua in the earth.

In the next place it is to be conſidered, that nature has furniſhed the earth with menſtrua, and other liquors of ſeveral ſorts, endowed with different qualities; and water being abundantly to be met with under ground, and for the moſt part very plentifully in mines, it is capable of being variouſly impregnated; and when thus altered, may, in ſome caſes, act the part of no deſpicable menſtruum; and on other occaſions concur to the production of mineral bodies.

I further obſerve, that the ſubterraneous liquors, upon one account or other, are qualified to act either as corroſive menſtrua, or as other ſolvents, upon many of the medicinal earths and minerals they meet with under ground; which having never been expos'd to our fires, preſerve their texture more open, and their parts more ſoluble, than thoſe that have been melted by the violent heat of a furnace.

And that even common water will ſuffice to diſſolve, and impregnate it ſelf, both with the ſaline and metalline parts that it meets with in its paſſage, appears from the different taſts, and other qualities of liquors, which all paſs for common water; ſome whereof are found better than others, for brewing, waſhing, dying, tempering ſteel, &c.

But more eminent inſtances are afforded us by the mineral ſprings, whether *Thermæ* or *Acidulæ*, great numbers whereof are enumerated by phyſicians and geographers; and many more wou'd, doubtleſs, be diſcovered, if men wanted neither skill nor diligence. And tho' common water does the moſt readily diſſolve the ſalts, properly ſo call'd, it finds in the bowels of the earth; as we ſee happens in thoſe ſalt ſprings that come not from the ſea; yet there are many other ſubterraneal bodies, which, abounding with ſaline particles, will be diſſolved by water, tho' they prove of a compound nature, and contain very different ſubſtances; as is plain from thoſe waters of *Hungary*, and other regions, that, by evaporation, yield vitriol, which contains a ſaline, a ſulphureous, a metalline, and an earthy part; every one of which may be made diſtinctly to appear.

The formation of gems.

Laſtly, the petrifying juice or ſpirit, coming in a ſufficient proportion to be mixed with theſe impregnated waters, ſo as to coagulate them, and unite therewith, from their coalition may reſult thoſe ſtones we call tranſparent gems. For 'tis certain, that bodies which were, a while before, in the form of water, may coagulate into ſtony *Striæ*; and that diamonds themſelves, the hardeſt of gems, were once fluid ſubſtances, I hope we have already proved.

But farther, having procured ſome petrified bodies from a place in *England*, I found that the petrifying juice, or ſpirit, which abounded in that ſpot of ground, was ſo penetrating and operative, that it render'd ſome of the vegetable ſubſtances, found there, of their priſtine ſhape and bigneſs, hard enough to cut both glaſs and iron. And from among theſe I pick'd a tranſparent body, that by the ſhape and other circumſtances I judg'd to have been a diaphanous gum, belonging to a piece of petrified wood, which was hardened to a degree that made it capable of ſcratching glaſs.

Their virtues, whence?

To apply theſe particulars to our ſubject: I conceive that ſome of the real virtues of gems may be derived from hence, that whilſt they were in a fluid form, the petreſcent ſubſtance was mixed with ſome mineral ſolution, tincture, or other impregnated liquor; and that theſe were afterwards concoagulated, or united and hardened into a gem. And as ſeveral virtues of gems may, in general, be deduced from the commixture of theſe mineral corpuſcles; ſo the greatneſs and variety of their particular virtues may proceed from the peculiar nature of the different impregnating liquors, and from the proportion wherein they are mix'd with the petreſcent juice.

To render this conjecture the more probable, it muſt be remembered, that we have already ſhewn gems to have once been fluid or ſoft bodies; and that ſeveral of them were not ſimple concretions of a petreſcent liquor, but conſiſted alſo of other mineral adventitious parts; as appears from the ſeparableneſs of ſuch ſubſtances in ſome ſtones, the ſpecific gravity in others, and the different tinctures to be met with in gems of the ſame ſpecies, as rubies, ſapphires, granats, and even diamonds; of which, as I formerly ſaid, I have ſeen ſome yellow, ſome of other colours, and ſome green, almoſt like emeralds.

Since, then, there may be in gems, and in ſome of them numberleſs adventitious corpuſcles; ſince there is cauſe to think, that ſome of them may be endowed with ſeveral properties and medicinal virtues; ſince there is a great difference among theſe impregnating particles, and, probably, a greater variety than is known to us; and, laſtly, ſince many gems are richly impregnated with theſe particles, I ſee no reaſon why ſome of the virtues of ſeveral gems may not proceed from hence, rather than from thoſe unintelligible and precarious ſubſtantial forms to which they are uſually referr'd.

Whether gems have, really, any medicinal virtues?

It may, however, be objected, that the mineral ſubſtances cannot well have any medicinal operation on the human body, becauſe they are ſo lock'd up as to communicate nothing to it; being unconquerable by ſo ſmall a heat as that of the ſtomach, and other parts Now, if there had never been any actual trial made, to ſhew whether a gem be capable of medicinal virtues, I ſhou'd find probability enough in this objection, to ſuſpend my judgment till experience determined the queſtion. But ſince, upon very credible teſtimony of eminent phyſicians, and patients themſelves, of my own acquaintance, I find cauſe to aſſent to ſome matters of fact about the operation of gems; and ſince ſuch facts ſtrongly argue, in the general, that a precious ſtone may have medicinal virtues, I think the objection ſufficiently enervated by ſuch particular inſtances; ſo that it ought not to keep us from aſſenting to the poſſibility of the thing, eſpecially when there are other particulars to be alledg'd in favour of our hypotheſis. For vigorous load-ſtones emit copious effluvia; and tho' they are uſually a hard ſort of ſtones, I have met with ſome, poſſibly, much harder than ſeveral gems. And 'tis farther conſiderable, that there are magnets which have a manifeſt and inconvenient operation upon the human body, by being wore in the pocket, or long held in the hand.

But farther, I have found ſeveral tranſparent pebbles, ſome of which, by being barely well cut and ſet, are made to counterfeit diamonds, that may immediately be brought to emit copious and ſtrong ſcented ſteams. And if electrical attractions be owing to the effluvia of bodies, excited by rubbing; very ſlight alterations may ſuffice to procure expirations from tranſparent gems, many of which are electrical, and even the hardeſt of them, diamonds themſelves; one of which I keep by me, that upon a little friction attracts very vigorouſly.

And as to that part of the objection which pretends, gems are not to be digeſted by the heat of the ſtomach; I will not ſtay to examine how far the digeſtion of things, in the ſtomach, is owing to heat. But to make the objection valid, it ſhould be firſt proved, that ſuch materials can have no operation upon the human body, while they paſs thorough it, without undergoing any ſenſible change of bulk, figure, &c. as gems, when ſwallow'd, are ſuppoſed to do. For ſome chymiſts make bullets of the regulus of antimony, which they call *Pilulæ perpetuæ*; becauſe when they have perform'd their operation in the body, and are thrown out with the excrements, they may be employed again and again to the former purpoſe: nor do we know what analogy there may be between ſome juices in the body, and thoſe parts of mineral ſubſtances that impregnate gems. For tho' the *Oculus mundi* is reckon'd among the rare gems, yet if one of the beſt ſort be, for a while, kept in common water, it will, as experience aſſures me, receive an alteration obvious to the eye. I might here alledge the concurrent authority of many phyſicians, and the common practice of moſt, who, in their public diſpenſatories as well as private preſcriptions, order the fragments of precious ſtones to be taken inwardly, upon account of the virtues aſcribed to them. But I wave ſuch arguments as ſeem ſuſpicious. However, I my ſelf have, without heat, obtained a manifeſt tincture from ſeveral hard bodies, and even from a tranſparent ſort of gems, by means of a faint liquor diſtill'd from a vegetable ſubſtance, which is as temperately qualified and as plentifully eaten as bread. And whether ſome juices of the body, aſſiſted by the natural heat thereof, may not ſerve for menſtrua to ſome gems, I cannot with certainty ſay. But even the natural heat of a human ſtomach, nay, perhaps, of the external parts of the body, may be able, tho' not to digeſt precious ſtones, yet to fetch out ſome of their virtues; ſince, I am ſure, it makes a ſenſible alteration in the hardeſt ſort of them.

For I have a diamond, whoſe electrical faculty may be excited without rubbing, only by a languid degree of adventitious heat; and had in keeping another, which, by means of water made a little more than lukewarm, I cou'd bring to ſhine in the dark.

If it be further alledg'd, that tho' ſome virtues be allow'd to gems upon account of the minerals that impregnate them, yet 'tis impoſſible thoſe virtues ſhould be very great and various: I reply, that I deſire no man to believe all the ſtrange things, that even ſome learned writers aſcribe to ſuch ſtones; for the rarity of tranſparent gems, their luſtre, and the great value which their ſcarcity, and mens folly give them, emboldens ſome to ſay, that ſuch ſcarce and noble productions muſt be endowed with proportionable qualities.

But for a further anſwer to this objection, 'tis not improbable that there ſhould be in the earth a much greater variety of minerals diſſoluble by the ſubterraneal menſtrua, and capable of concoagulating with petreſcent juices, than authors have yet taken notice of; as many ſubterraneal productions, that I have met with, ſtrongly incline me to believe. And from the number and various mixtures of theſe, may proceed not only a great variety of operative particles in precious ſtones, but a high degree of energy in ſome of them.

Next, I conſider, that the efficacy of thoſe mineral tinctures, or ſolutions, already known to us, may be reaſonably preſum'd greater in ſome gems, whereof they became ingredients whilſt *in ſolutis principiis*, than can be expected from the vulgar ſolutions of the ſame metals or minerals, after they have, by vehement fires, been reduced into gold or ſilver, lead or antimony, *&c.* For in ſuch vehement fuſions as are requiſite to bring metalline ores into theſe ſubſtances, the volatile and ſpirituous parts will be driven away, and the remaining body become more hard and compact, and thereby have its virtues lock'd up. But in their ſtate of fluidity, thoſe ſubtile and efficacious parts are preſerv'd and united to the other ingredients of the gems, whence ſome of them may be eaſily drawn out; as I lately inſtanc'd in very hard pebbles, which afforded ſtrong ſcented effluvia. And from the greater or leſs plenty, and natural activity of the impregnating particles in a gem, may, probably, be deduced the difference of the colour in ſome, and of the virtue in others of the ſame denomination: of the latter caſe, we have eminent examples in ſome learned writers; particularly in the *Lapis nephriticus*.

And here we may obſerve, that the petreſcent juices themſelves may have diſtinct natures, and be endowed with peculiar qualities, abſtracting from thoſe they acquire, upon account of their coalitions with adventitious liquors; as ſome differences I have found in petreſcent fluids make probable. And having obſerved petrifying liquors or ſpirits, to pervade and give a high degree of hardneſs to bodies that chanced to lie within their reach, tho' one would have thought them ſufficiently indiſpoſed to receive ſuch an induration; I ſee no abſurdity in ſuppoſing ſuch a liquor may invade, permeate, and ſubdue tranſparent minerals, abounding in ſaline, ſulphureous, and bituminous particles; which being duly excited, may emit their more ſubtile and active parts. And as I have cauſe to think, that ſubterraneal fires and menſtrua, do often make various compoſitions, and re-compoſitions in the earth; ſo 'tis not impoſſible that the ſpirit we are ſpeaking of, may mix it ſelf with ſuch bodies, and petrifie them, together with it ſelf, into gems. I have had ſalt that was made by nature in the bowels of the earth, juſt like that the chymiſts compound by art. And I have ſometimes, by an eaſie operation, and a moderate degree of fire, made a certain compoſition of volatile particles of ſalt and ſulphurs, which, after diſtillation, ſhot in a fluid medium, into tranſparent cryſtals, more curiouſly figured than many natural gems. So that if either beneath, or upon the ſurface of the earth, ſuch kind of ſubſtances happen to be pervaded and ſubdued by a clear petrifying liquor, we may well preſume, that the reſulting concretions will be endued with qualities, both uncommon in kind, and conſiderable in degree.

If it be yet objected, that it is very unlikely gems ſhould part with any effluvia, or portions of themſelves, ſince they loſe none of their weight; and ſince ſome of them are very little heavier than cryſtal; I might leave phyſicians and chymiſts to reply, that the antimonial glaſs and cup imbue wine, and other liquors, with a ſtrong emetic quality, without ſuffering any ſenſible loſs of weight. But have the objectors tried the truth of what their argument ſuppoſes, by any method ſufficiently accurate? This, I doubt, has neither been attempted, nor wou'd be found eaſie to perform. And, till due experiments are made, let me repreſent, that tho' common water be not allowed a menſtruum fit to draw any thing from mercury; yet both *Helmont* and others inform us, that a large quantity of it being kept for a day or two upon a ſmall proportion of that drug, will acquire a virtue of killing worms; tho' the mercury retains its former weight. And this liquor is accordingly uſed for that purpoſe, and often with good ſucceſs, in a great hoſpital in *London*; as the chief phyſician of it, a very judicious and experienced man, has more than once inform'd me.

And as for the lightneſs objected againſt ſome gems, it may ſafely be granted, that, *cæteris paribus*, ſuch have more languid virtues than others of the ſame kind; but beſides, the adventitious ſubſtance that impregnates the petreſcent juice, may be of ſo ſmall ſpecific gravity, as not to make the gem at all heavier, in ſpecie, than cryſtal. For this, as we formerly obſerved, being to common water of the ſame bulk, as about 2½ to 1; I have hydroſtatically found, that ſeveral ſalts, and ſome other mineral ſubſtances, are of leſs ſpecific gravity than that; and conſequently, if theſe were concoagulated with the petreſcent juice that hardens into cryſtal, they wou'd not increaſe its weight, tho' they might imbue it with conſiderable virtues. But, by the way, it is not neceſſary that the adventitious ſubſtance ſhould be purely ſaline, to cauſe no alteration in the tranſparency of cryſtal, or the colour of other gems. For I have often made bodies, which, tho' tranſparent and colourleſs, like cryſtal, and ſometimes curiouſly and regularly figured, were yet of a compound nature; and particularly abounded with a ſtrongly ſcented ſulphur that was eaſily ſeparable therefrom. But, to give a more direct anſwer to the objection, I ſhall add, that tho' when a gem has a much greater ſpecific gravity than cryſtal, or will allow an adventitious mineral to be ſeparated from it, 'tis a very probable argument, that the petreſcent juice is that body compounded with another ſubſtance; yet it will not neceſſarily follow, when neither of theſe ſigns appear, that the gem is quite free from ſuch a ſubſtance. For the petreſcent liquor, whereof it principally conſiſts, may be impregnated with the finer and more ſpirituous part of the mineral, without having its ſpecific gravity ſenſibly increaſed. Of this I received a notable inſtance from a mineral water; for tho' that water, by its inky taſt, by its colouring the excrements of thoſe who drank it, *&c.* appeared greatly to participate of iron; yet the particles of that metal were here ſo light and ſpirituous, as not only to fly away if the liquor were kept negligently ſtopped; but examining it hydroſtatically, when freſh drawn, I found it very little, if at all heavier, in ſpecie, than common water, compared and examined in the ſame ſcales, after the ſame manner, and with the ſame exactneſs.

If to all this be added, a conſideration drawn from the atmoſpheres of ſolid bodies, and the great efficacy of effluvia, it will appear but natural to ſuppoſe, that ſome precious ſtones may have medicinal virtues; and that many of them may be aſcribed to the mineral ſubſtances whereof they participate or conſiſt; and eſpecially to thoſe which are beſt fitted to exert their powers, by a copious efflux of their more ſubtile parts.

Animal and vegetable ſubſtances petrified, whilſt their f[illegible] appear [illegible]

'Tis true, what has been hitherto delivered, chiefly regards tranſparent gems; yet a great part of it may be apply'd to opake ones. And if I have ſhewn, that even diaphanous gems may be endowed with virtues, by the mineral ſubſtances they contain, the arguments will hold more ſtrongly as to opake gems; for theſe are, for the moſt part, ſofter than the others; and 'tis far more eaſie to ſhew, by their ſpecific gravity, and the mixed nature of ſeveral of them, that the dark ones may greatly conſiſt of mineral ſubſtances, incorporated and hardened with petreſcent juices. And among the ſeveral kinds of theſe liquors, I have obſerv'd one of ſo fine a ſubſtance, yet of ſo petrifying a virtue, that it will penetrate bodies of very different kinds, and turn them to ſtone, without ſenſibly increaſing their bulk, or changing their ſhape or colour. By this means, I have ſeen ſeveral animal and vegetable ſubſtances ſo petrified, as ſcarce to be diſtinguiſhed, by their appearance, from natural. Thus, for inſtance, a thin cream cheeſe was turned into ſtone, whilſt the ſize, ſhape, and colour, even of the wrinkles, and the bluiſh mould, were ſo well preſerved, that it might eaſily have been thought eatable. I have alſo had a conſiderable quantity of wood ſo petrified in *England*, which retaining its former figure and grain, and being ſcarce at all viſibly increas'd in bulk, was ſo very hard, that I cou'd make impreſſions with it upon iron, and even glaſs it ſelf, and ſtrike fire with it, as if it were an excellent flint: and the ſtony parts hereof wou'd not ſuffer the wood, which they had penetrated, to be reduced in the fire either to aſhes or charcoal. I have likewiſe now by me a lump of mineral ſubſtances, wherein a petreſcent liquor, that fills the large intervals between them, is tranſparent, and harder than moſt ſtones; as far as we cou'd gueſs by ſome trials made upon it, by a ſkilful engraver of gems.

'Twere eaſie to add other inſtances of this kind; but theſe may ſuffice to ſhew it poſſible, for petrifying agents to inſinuate themſelves into the pores of various bodies, and turn them into ſtone; without otherwiſe deſtroying their priſtine nature, or ſo much as altering their figure.

And now, to render our hypotheſis the more probable, I ſhall offer a few arguments, drawn from the great ſpecific gravity of ſeveral opake, medicinal ſtones; from the fitneſs of our ſuppoſition to account for ſeveral phenomena, ſome of which are ſcarce at all, and others much leſs probably to be accounted for without it; from the metalline ſubſtances, manifeſtly to be obtain'd from the ſtones we are treating of; and laſtly, from the nature of the bodies whereof medicinal ſtones ſeem to be compoſed.

Opake ſtones, examin'd hydroſtatically, and thence ſhewn to be mixed with mineral ſubſtances.

1. That the ſpecific gravity of opake ſtones, whereto medicinal properties are aſcribed, is very conſiderable, might have been eaſily diſcovered from hydroſtatics, if the writers upon ſuch concretions had been vers'd in that doctrine. Now, as marble is generally allowed to be a pure and ſolid ſtone, and, upon account of its whiteneſs, likely to be free from mineral mixtures, I choſe that for the ſtandard of the ſpecific gravity of opake ſtones; and, accordingly, having weighed a piece of it, in air and in water, I found it to be to an equal bulk of that liquor, very nearly as $2\frac{7}{10}$ to 1. And to make trial in a ſtone uncoloured, but ſuppos'd of a cloſer texture, we examined a fine white pebble, and found it was to an equal magnitude of water, as $2\frac{6}{10}$ to 1. Hence 'twas eaſie to infer, that ſeveral bodies, which commonly paſs for mere ſtones, are more ponderous than white marble of the ſame bulk; and that if there were any great exceſs in the ſpecific weight of ſtones, above that of marble, it might proceed from ſome metalline body, mixed with the petreſcent matter thereof. And I ſoon found, by weighing the following minerals, firſt in air, and then in water, that a blood-ſtone was to an equal bulk of water, as $5\frac{7}{10}$ to 1; the load-ſtone as $4\frac{6}{10}$ to 1; *Lapis Calaminaris* as $4\frac{7}{10}$ to 1; and *Lapis Tutiæ* very near as 5 to 1.

But I have not found the proportion of each of theſe bodies to water, to be any thing near conſtantly the ſame; but ſometimes to differ very much in particular ſtones of the ſame kind; which agrees very well with our hypotheſis: for, according to that, the ſtones which happen to partake more plentifully of mineral ſubſtances, heavier in ſpecie than ſtone, ought to be more ponderous than others of the ſame kind that are not ſo qualified. From jet, a foſſil found in ſome parts of *Europe*, which is reckoned among ſtones, and worn by many as a gem, I obtained no inconſiderable proportion of oil; and having weighed choice jet it ſelf in water, I found it to be bulk for bulk to that liquor, but as $1\frac{22}{100}$ to 1. And there are ſome other foſſils, hard as ſtone, and poliſhable as marble, from which I have, by diſtillation, obtained two kinds of oil, whereof one was lighter than common water; which ſhews, that even bituminous and light ſubſtances may be ingredients of a ſtone: and that ſalts, which are moſt of them lighter in ſpecie than white marble, may plentifully concur to the making up of ſtones, will appear from thoſe, whereof we in *England* make vitriol. Stones, therefore, which are lighter in ſpecie than white marble, may be compounded of foſſils, and thence derive peculiar qualities; at the ſame time that ſuch as are conſiderably heavier than that, may juſtly allow us to ſuſpect, they owe their gravity to the mixture of metalline or mineral ſubſtances.

The manner wherein gems and ſtones are found to grow.

2. I have learn'd of travellers returned from the *Eaſt-Indies*, that ſometimes one ſort of tranſparent gems, ſometimes another, and ſometimes even diamonds themſelves, are found included in the rocks, or in the midſt of hard, looſe ſtones, which muſt be broken in pieces before they can be obtained. Which phenomenon is hard to ſolve without our hypotheſis; but according to that, it may rationally be ſuppos'd, that the gem was firſt formed, either in earth, or ſome other ſoft and permeable ſubſtance; which being afterwards pervaded by ſome petrifying juice, was turn'd into rock, or looſe ſtones, according as the earth, and other ambient matter, chanced to be an entire and coherent maſs, or divided into clods and parcels. And the governour of an *American* colony having ſent me, among other curioſities, an odd kind of mineral, that ſeemed more ponderous than at firſt ſight it promiſed; I had the curioſity to break it, and found up and down therein ſeveral gems; which, by their figuration, and ſome other circumſtances, were concluded to have been form'd there, before the ambient mineral had obtain'd the nature it then appear'd to be of. And it may happen in opake ſtones, that a great lump of medicinal earth ſhall be invaded and petrified after the ſame manner. Whence it need not ſeem ſtrange, that ſome medicinal ſtones ſhou'd be very large in compariſon of others. Thus I remember, a phyſician to'd me of a ſpleen-ſtone in the hands of an acquaintance of his, which weighed 80 *l.*; and I have ſeen lumps of medicinal ſtone, much

harder and heavier than marble, that were far greater than I cou'd lift: and having caus'd a pretty big piece to be violently broken off from the maſs whereto it belonged, and to be ſawn aſunder, I found ſeveral empty cavities, of different ſizes and figures, in the ſolid ſubſtance of the ſtone; which ſeems to argue, that this compact and ponderous body was made ſtony, by the ſupervention of ſome petreſcent liquor upon porous earth, or other conſiſtent ſubſtance. For if it had been a mere liquor, wherein thoſe cavities were ſo many aerial bubbles, 'tis not probable, that ſome of them ſhou'd have ſuch irregular ſhapes, and that all ſhou'd have continued without emerging to the top.

Our hypotheſis will alſo help us to explain, how ſome gems, which ſeem to be entire ſtones, are of different colours in contiguous parts; as the ſardonyx, and ſome other opake gems: I have, alſo, obſerv'd the like, tho' rarely, in diaphanous ones. For, according to our hypotheſis, it may be ſaid, that a portion of matter imbued with one of the tinctures of the party-colour'd gem, was firſt form'd; and afterwards ſome petreſcent juice, endowed with another colour, came to ſettle contiguous to it; and ſo by accretion made up one ſtone with it. This might be illuſtrated by conſidering, that tho' fire makes a far greater agitation of the bodies melted by it, than need be ſuppos'd in cold petreſcent liquors; yet I have found, in making artificial gems, that by ſome miſchance, or error, in the operation, the mineral pigment has richly tinged one part of the tranſparent maſs, without at all imparting that colour to the very next part to it. One of theſe I have yet by me, which wou'd be judg'd to conſiſt of two differing gems ſubtilely glew'd together.

But in natural gems, the union of parts might be the more perfect, if the ſupervening matter found not the ſtone firſt form'd, to have attained its full induration. Tho', for ought I know, even in this caſe the appoſition may be ſo cloſe, and the two materials ſo near of kin, that they may both paſs for one ſtone, and be poliſhed together; without any diſcontinuity appearing in the ſurface: for I have by me, a lump, wherein there plainly appear ſtones of very different colours from each other, that were once diſtinct and incoherent; but by ſome petreſcent liquor, have had all their intervals ſo exquiſitely fill'd up, that neither the touch, nor the artificer's tool, when the lump was ſawn aſunder, cou'd diſcover any commiſſures; but the whole maſs bears an uniform poliſh, and is harder than ſeveral gems that are worn in rings, and will readily ſtrike fire with a ſteel. And for farther confirmation hereof, in the place where this portion of petrified matter was found, not only other lumps, but many looſe ſtones were diſcovered, which ſeem'd altogether of the ſame nature with thoſe, that by the ſupervention of the petreſcent liquor, were united into ſtony maſſes. I have, alſo, had a curious agate ſo form'd, that it ſeemed highly probable, that the opake parts of its matter had been ſome thin ſeparate beds of fine clay or earth, lying almoſt parallel to each other; which, by a petreſcent liquor that ſettled there, was reduced to coagulate with it into a ſtone, partly opake, and partly diaphanous. And of ſuch clays or mineral earths, I have obſerved more than one or two, which, tho' diſtinct, and, perhaps, of different colours, yet the thickneſs of them all ſcarce exceeded an inch; nor did they always lie flat or horizontally, but in differing poſtures, both with regard to the horizon and one another; and now and then the exterior ones, ſucceſſively, almoſt ſurrounded the interior. And of theſe thin couches or layers of earth, I have found a conſiderable number within a very ſmall compaſs of ground. The production of ſeveral other gems, as chalcedonians and jaſpers, which are generally opake, but have ſome parts tranſparent, may alſo, probably, be explain'd in the ſame manner. 'Tis here remarkable, that by purpoſely calcining ſome of theſe ſtones entire, whoſe greater part was diaphanous, I found that the tranſparent parts turn'd white, and that ſome of the thin couches of mineral earth had retain'd, not only their poſition, but their colour, which ſeem'd much heighten'd; ſo that one of theſe layers, after calcination, appeared of a very rich and permanent red. And this difference of colours, I obſerved, not only in layers, but in the ſpecks and irregularly ſhap'd clouds of other colours. I might here add, that I have found ſhining marcaſites, not only in other ſolid ſtones, but in marbles and flints themſelves. Thus, alſo, I have found wood in ſtrong ſtones employed to build houſes, and ſhells in a great maſs of ſtone, that I met with almoſt on the top of a hill, remote from the ſea. Now theſe, and the like phenomena, may be, probably, accounted for by our hypotheſis, and ſcarce without it. But even in tranſparent gems, and which is more, of the ſame ſpecies, I have ſometimes taken notice of ſuch an accretion of ſtones as argues their having been produced at ſeveral times. For proof of this, I need only repeat what I formerly ſaid of thoſe *Corniſh* diamonds, wherein, ſometimes, a leſſer ſtone, tho' geometrically ſhap'd, was found in good part inclos'd in a greater, and in part, alſo, extant above it; whence I argue, that the production of this aggregate of two cryſtalline bodies, was not made all at once, but ſucceſſively; and that the leſſer was firſt formed; which I ſhall now confirm by this conſideration: that if the greater ſtone had been firſt harden'd, the matter of the leſſer muſt only have ſtuck to it externally, and been, as it were, imboſs'd upon it; but cou'd not have made it ſelf a bed, or mould, in the ſubſtance of the greater, eſpecially of ſuch a geometrical figure as it ſelf had not yet receiv'd.

I cauſed two ſolid fire-ſtones, ſuppoſed to be uniform and entire maſſes, tho' of very different ſizes and ſhapes, and brought from diſtant places, to be warily broken; whereupon I obſerved that part of the internal texture of the leaſt of theſe minerals, which was almoſt ſpherical, greatly differ'd from that of the more internal ſubſtance; and that in the largeſt mineral there was a little globular ſtone, manifeſtly not of the ſame piece with the ſurrounding maſs, but differing from it, not only in texture, but here and there by a diſcernible commiſſure; tho' in moſt places their adheſion was ſo ſtrict, that we could not make any ſeparation of the two minerals in this commiſſure.

And tho' this ſucceſſive generation of the parts of entire gems, may appear ſomewhat new and ſtrange; yet that its fitneſs to explain the foregoing phenomena, and others, may the more recommend it, I ſhall here give it a mechanical illuſtration. We ſee, then, in ſeveral chymical ſolutions, as of ſalt and other bodies, that there are certain ſtages or periods of coagulation; ſo that when ſuch a quantity of the ſuperfluous moiſture is exhaled, eſpecially upon any conſiderable refrigeration, or other favourable circumſtances, thoſe particles that are moſt diſpoſed to coagulation, will convene and ſhoot into cryſtals, after which, no more will ſhoot till a farther evaporation be made; but upon a repetition hereof, a new cryſtallization of the parts will enſue. And I can ſhew the productions of a metalline ſolution, ſo made in an appropriated liquor, that the firſt ſhooting afforded a layer of curiouſly figur'd cryſtals; and the following, another of fine cryſtalline bodies, that have faſtened themſelves to the former, but differ conſiderably from them both in ſhape and poſture. And in this experiment, both the diſſolved materials and the menſtruum, were ſingle bodies. But if there be a diverſity of nature in the liquors that make up a menſtruum, or in the bodies that are diſſolved in it, ſome of the corpuſcles may convene, either a-part with thoſe of the ſame nature, or as mix'd with thoſe of a different one at the ſame time; and ſo make up cryſtals of a compound nature. Some of them, alſo, may convene with homogenous particles, at different times, and ſo fail of ſuch an uniformity as might otherwiſe appear in their concretions. This may be illuſtrated by the cryſtallizations of ſalt-peter and ſea-ſalt, diſſolved together in common water, whence grains of ſalt of the figures thence reſulting, are uſually produced; and, alſo, a conſiderable part of the ſea-ſalt coagulates in the form of imperfect cubes, about the bottom, before the nitrous corpuſcles ſhoot into cryſtals of their own priſmatical figure: and it matters not whether the ſuperfluous water be exhaled or drawn off by a material fit to ſoak it up; as we have had occaſion to obſerve in accelerating the cryſtallization of ſome bodies.

In conformity with ſuch inſtances as theſe, we may conceive, that where there are petreſcent liquors mix'd with common water, there may by ſeveral accidents, and particularly by a hot ſummer, be made a ſufficient diſcharge of the ſuperfluous moiſture, to cauſe the more diſpoſed parts of the petreſcent liquor to coagulate; and afterwards the coagulation may be ſuſpended, either by the ſupervention of a colder ſeaſon, or even in ſummer it ſelf, by a plentiful rain, or the effect of it, a land-flood, which might check the progreſs of ſuch coalitions, by diluting the fluid which would otherwiſe have turned into ſtone.

And trial hath aſſured me, that there are bodies of very different kinds, which will, in tract of time, eſpecially if their coalition be farther'd by cold weather, coagulate after they have long remained fluid; tho' the water, or other menſtruum, by being encloſed in ſtopped glaſſes, be kept from waſting. And ſince the earth harbours different kinds of theſe liquors, and many of them may be copiouſly impregnated with one ſort of mineral or other, they may have diſtinct periods for their reſpective coalitions, and yet ſtick cloſe to one another. For tho' in chymical cryſtallizations we uſually take out of the veſſel, what ſhoots the firſt time, before a freſh exhalation be made for a new cryſtallization, and by this means find the coagulated bodies obtain'd at one time, more uniformly ſhap'd than at another; yet in the hollow receptacles which the earth affords to petreſcent liquors, the veſſel continuing the ſame from firſt to laſt, the uniformity of the bodies produc'd by coalitions, made at ſeveral times, muſt be leſs regular, and the manifeſt accretions of coaleſcent bodies, in all likelyhood, be more frequent. And, accordingly, having long continued the exhalations of ſome liquors, in the ſame veſſel, I had coalitions of very different bodies at the bottom. I might add, that in ſome circumſtances, even in theſe veſſels, and therefore without any manifeſt exhalation of the water, or other menſtruum, and, ſometimes, where the diſſolved body was homogeneous, I have, in proceſs of time, had coagulations, where the cryſtals laſt formed ſeemed plainly to have been generated by way of accretion to the firſt.

Whence it is that ſtones of various kinds, petrified animals, &c. are found in dry places, ſolid rocks, &c.

I ſhall now endeavour to clear a grand difficulty, which I foreſee may be objected to our hypotheſis; namely, that theſe accretions, of medicinal or other ſtones, are, ſometimes, found in places where there are no petrifying ſprings, and, perhaps, no water at all; nay, little or nothing but quarries, or maſſes of ſtone.

To this I anſwer: firſt, that if we admit the relations of approved authors, concerning men and beaſts being ſuddenly turn'd into ſtone, by a petrifying ſpirit; it is not abſolutely neceſſary there ſhould be any petreſcent ſprings, or other water, to produce ſuch minerals as we are ſpeaking of.

(2) For any thing that has hitherto appeared to the contrary, we may ſuppoſe that rain-water, ſometimes, brings along with it ſuch petrifying particles as may ſerve our turn. I am informed, by a judicious perſon, who viſited a famous bath in *Hungary*, the water whereof greatly abounds in petreſcent particles, that to the roof of a tall ſtructure which ſtands over it, there were faſten'd many long ſtony concretions, affirmed by him to be generated there from time to time, not by the daſhing up of any drops of water, which could not reach near ſo high; but by the copious petrific ſteams, that being there check'd in their aſcent, coagulated, according to their natural propenſity, into ſtone. Hence it ſeems not impoſſible, that ſtone ſhould, in ſome places, be generated without the help either of rain or ſprings, by the aſcent of pe-

trific particles in the form of exhalations, from the lower parts of the earth; which exhalations ſuffering the lighter ſteams that accompanied them to exhale, may operate upon ſome diſpoſed materials which they find in their way, and turn them into ſtone; and indeed the earthy, and ſometimes ſulphureous ſediments, that have been obſerved at the bottom of rain-water, ſuffered to ſettle in clean veſſels, may ſeem to favour ſuch a conjecture: which receives an illuſtration from what I obſerv'd in a bottle of diſtilled liquor, whereof no part wou'd naturally aſcend in a dry form; but having kept it well ſtopp'd in a ſafe and quiet place for a year or two, the aſcending ſteams had quite pervaded the cork, and formed at the top of it numerous, whitiſh, ſlender *Striæ*, of a ſurprizing length.

(3.) There is no neceſſity that in all ſoils where petrific waters are found, petrifying ſprings ſhould appear, at leaſt above ground; for I have ſeen numberleſs figured, and tranſparent ſtones, dug up in a certain earth, that lay upon the upper part of a rock, and ſeem'd to be a very dry ſoil; and by pouring a ſolution of ſtony *Striæ*, made with ſpirit of verdigreaſe, on a convenient quantity of bole-armeniac; and ſuffering the ſoft mixture to remain in a glaſs in the open air, till the ſuperfluous moiſture was exhal'd, I have found ſmall, unting'd, figur'd cryſtals, diſpers'd thro' the little cavities of the red earth. But 'tis conſiderable to our preſent purpoſe, that the faireſt and hardeſt petrified wood I ever tried, was taken up in a plot of ſandy ground, where no petrifying ſpring, or other water, was to be found. And ſuppoſing the ground to have been once moiſtened by a petreſcent liquor, brought thither by ſprings, or any other way; our hypotheſis will ſhew how, on the ſurface of the ground, and perhaps upon rocks themſelves, aggregates of figured ſtone may happen, that ſeem to grow upwards, as it were, from a root; which uſually puzzle men to know how they came there; and may incline them to aſcribe vegetation to ſtones. But to this it may be reply'd, that many of the concretions might have been formed in wombs, that lay, tho' not deep, yet under ground, or in ſhallow cavities, in the ſurface of it; and that after their formation, the looſer earth, which ſurrounded them, may have been waſh'd off by rains, blown off by winds, or otherwiſe remov'd; leaving behind them theſe ſtones that adhered firmly to a ſolid body. 'Tis alſo very poſſible to ſhew, that ſtony concretions might be produced by the mechanical action of the air upon the ſtony particles, which ſucceſſively apply themſelves to the matter that firſt begins to coagulate, when they are ready to be forſaken by the moiſture that accompanied them, and was neceſſary to their due application to the caſual rudiments, which paſs for roots; in imitation whereof, I have more than once obtain'd, both from ſaline and ſtony ſolutions, dry tufts of prettily figured, diaphanous, or white, ſlender *Striæ*, that ſeemed to grow out of the

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Nat.Hist. containing glaſs, and made perſons wonder how they came there; no water, or other liquor, appearing near them.

(4.) It may eaſily happen, that the petreſcent liquor ſhall be ſo mixed and diluted with ordinary water, as not to be diſtinguiſh'd from it, nor be capable of diſcloſing itſelf by its effects; till either by a large exhalation of the common water, or by ſome peculiar advantages it has to operate upon bodies, it gains a proper opportunity. There is a lake in the north of *Ireland*, wherein fiſh live, as well as in other lakes; tho' there are ſome rocks at the bottom of it, to which many maſſes, and pieces of a finely figur'd ſubſtance, tranſparent as cryſtal, faſten themſelves. Now if we ſuppoſe, that either by ſprings of petreſcent water, or by rains, or by ſubterraneal ſteams, or, otherwiſe, waters reſting in any hollow place, tho' upon the tops of rocks or mountains, ſhall be ſufficiently impregnated with petrific particles; and that afterwards, in proceſs of time, the merely aqueous parts ſhall gradually, by the heat of the ſun, the ſoaking of the ground, the winds, or the continual action of the air, be brought to exhale away in the form of vapours; the petrific particles, which are not ſo volatile, will turn the ſoil beneath them, and on the ſides of them, as far as the ſphere of their activity reaches, into ſtone, harder or ſofter, and into this or that kind, according to the particular nature of the petreſcent liquors, and the ſtructure, and other diſpoſitions of the ſoil they invade; in which ſoil, if there chance to be lodg'd bodies heterogeneous to it, whether vegetable ſubſtances, as roots, gums, *&c.* the whole bodies of animals, as toads, frogs, ſerpents, *&c.* or their parts, as ſhells, bones, *&c.* or minerals of an open texture, as boles, unripe ores, or elſe gems, or ſtones of another kind already form'd; any of theſe things, or any other that ſhall chance to be lodg'd there, muſt be found either petrified, or inclos'd in ſtone, when this harden'd ſoil ſhall come to be broke up. Nor is it at all neceſſary, that ſuch petrifaction of the extraneous bodies, and of the ſoil or bed, be made at once; for it may well happen ſucceſſively, at ſeveral times, according as ſome parts of the petreſcent juice are more copious and penetrating; and conſequently more fit to be ſoaked in, further than others. For as the poroſity happens to be greater in one part of the ſoil, than in another; or as the texture and diſpoſition of the particular bodies lodged in the earth, give advantage to the petrifying particles to work on ſome of them ſooner, or in a different manner than in others; ſo the induration of the pervaded ſubſtances may be very unequally made in point of time, as well as in other circumſtances. Whence it appears, how medicinal ſtones, of very different colours, conſiſtencies, and operations, may be generated, and ſeem entire bodies, tho' one part of them be dark, heavy, and opake; and the other much lighter, tranſparent, and quite of another colour. And upon the ſame principle may be explained, the manner wherein diamonds are inclos'd in looſe ſtones, or even in rocks; of which we have credible teſtimony. Nor does this appear more ſtrange, than that a ſtone, which I have by me, a kind of pebble, ſhould contain a perfectly ſhap'd ſerpent, coiled up in it, without a head; which ſeems to have been form'd before the ſtone, becauſe in the upper and lower parts of that ſolid, there are cavities left, that together make up one entire cavity, juſt of the ſize and ſhape of the contained body; whereto, as it was eaſie for the matter of the ſtone, whilſt ſoft, to accommodate it ſelf exactly; ſo 'tis ſcarce conceivable how, if the pebble had been firſt form'd, the inclos'd animal, if it were one, or the matter in that form, ſhould not only get in, but find a cavity ſo curiouſly ſhap'd, and fitted to its bulk. And that this variety was produced at ſeveral times, might be farther argued from hence, that the ſeeming ſerpent is plainly another and clearer kind of ſtone, than that of the mould which includes it; and of the mould it ſelf, one part contiguous to the included body is whitiſh, and abounds in ſhining grains, or flakes; in both which it differs from the other, which is far the greater part.

(5.) In thoſe very places, where now there is nothing to be ſeen but looſe ſtones, there may formerly have been petreſcent liquors, either ſtagnant or running; for earthquakes, inundations, ſinkings of the ground, incroachments of the land on the water, fiery eruptions, and ſuch accidents, may, among other odd effects, have dry'd or choak'd up pools and lakes, and quite ſtopp'd, or diverted the courſe, both of ſprings and rivers, ſo as to leave no remaining ſigns of them. Upon this account, and other great changes in the ſtructure and diſpoſition of the ſoil of ſeveral places, it may well be ſuſpected, that the ſtony moulds, wherein the above-mentioned bodies were found, might heretofore have been of an earthy nature, and the receptacles of petreſcent liquors, which, at ſeveral times, turn'd the whole maſs of the ſoil into ſtone, before the ſprings, or other waters, containing the petrific liquors, were quite conſumed, or had their courſe altogether diverted. And many things might be produced to ſtrengthen this conjecture.

The tinctures and ſolutions of ſtones abound in metalline or mineral particles.

3. It agrees very well with our doctrine about the great ſpecific gravity of theſe ſtones, in compariſon of white marble, or tranſparent pebbles, that it is poſſible out of them, to extract ſome of the ſubſtance ſuppos'd to give them that additional ponderoſity. And, accordingly, we have, by appropriated menſtrua, obtained from ſuch bodies, ſolutions or tinctures; which, not to inſiſt on their colour or taſt, wou'd, upon their being dropt into a tincture of galls, or other convenient liquor, produce ſuch phenomena, as argued them to abound with metalline or mineral particles; which, for the moſt part, I obſerved to be of a vitriolic nature. Thus I found, that the ſolution of a blood-ſtone, which taſted very rough upon the tongue, wou'd with the infuſion of galls, make an inky mixture; and the

like happened with load-ſtone, emery, marcaſites, *&c.* open'd by corroſive menſtrua. But the ſolution of *Lapis Calaminaris,* which was of a golden colour, did not operate like the reſt on the infuſion of galls; yet by its taſt, as well as colour, ſufficiently ſhew'd it ſelf to have copiouſly impregnated the menſtruum. The mention of *Lapis Calaminaris,* reminds me of an inſtance of there being other ways, beſides that of diſſolution, in proper menſtrua, to ſhew that ſome medicinal ſtones participate of metalline and mineral ſubſtances; for it is by melting this ſtone with copper, and keeping them together for a competent time in fuſion, that braſs is made; wherein the red colour of the copper is changed into a golden one, and the abſolute weight conſiderably increaſed. Nor is this the only mineral ſtone from which I have, by a way quite different from thoſe hitherto mention'd, namely, with running mercury, obtained a metalline ſubſtance. And tho' native cinnabar be looked upon by the vulgar as a red ſtone, yet 'tis known, in the quick-ſilver mines, to be a mercurial ore; whence, by vehement fires, they diſtil running mercury, as we by a moderate one have ſometimes done.

Even the lighter ſtones may be mixed with metalline matter.

There are, however, ſome ſtones, that have uſeful qualities aſcribed to them, tho' they appear to be not at all, or ſo little heavier *in ſpecie,* than is requiſite for a mere ſtone, as to render it very unlikely, that metals, or ponderous minerals, ſhould contribute to their production or virtues.

But our hypotheſis does not oblige us to deny, that there may be ſuch ſtones; for tho' it aſcribes the virtues of moſt gems and ſtones to the metalline and ponderous mineral ſubſtances they partake of, yet the conceſſion agrees very well with our doctrine; which teaches, in general, that the virtues of ſtones may, in many caſes, depend upon their being impregnated with other minerals; which, tho' they moſt commonly prove ſpecifically heavier than the mere petreſcent matter, yet in ſeveral ſtony concretions, the adventitious ingredients may be ſpecifically lighter than the genuine matter of the ſtone; as we have formerly ſeen in ſeveral bodies which paſs for ſtones. Thus not to repeat what has been ſaid of ſalts, I have obſerved that ſome other hard foſſils abound with a kind of bitumen, which, when, by diſtillation, brought to an oil, is much lighter than a ſtone of the ſame bulk; and I have had ſome portions of ſuch oil that wou'd ſwim even upon common water. And leſt this ſhould be aſcribed to the ſubtilization the bitumen received from the fire, I will add, that having hydroſtatically weighed a piece of good *Aſphaltum,* we found it to be to water of the ſame bulk, but as 1, and ſomewhat leſs than $\frac{4}{10}$ to 1; which was within a tenth of the proportion of a ſtony bituminous foſſil to water, commonly call'd in *England, Scotch* coal. And becauſe ſulphur, as well as bitumen, is very apt, even by a moderate heat or attrition, to diffuſe its ſteams; let it be noted, that there are various hard ſtones which abound in ſulphur; and yet having weighed a roll of brimſtone in air and water, I found it to be but a trifle above double the weight of the latter, which ſhews it was much lighter *in ſpecie* than cryſtal.

Hence we may argue, that 'tis not impoſſible the principal virtue of a light medicinal ſtone, ſhould be due to ſome mixture of a metalline, or the like ponderous ſubſtance; ſince if ſome of the ingredients that are plentifully mix'd with the true ſtony matter, be of the lighter ſort, tho' there be alſo ſome metalline, or other heavy mineral particles mixed with the ſame matter; yet the leſs ſpecific gravity of the one, in compariſon of this matter, may compenſate for the greater of the other; and ſo together compoſe a ſtone not more ponderous than white marble. Thus I have found a blackiſh *Eaſt-Indian* flint, and likewiſe a black *Engliſh* one, to have to water not full the proportion of 2$\frac{6}{10}$ to 1; and that a piece of black marble, which I examined hydroſtatically, was, notwithſtanding the darkneſs of its colour, to water of the ſame bulk, ſcarce any thing more than 2$\frac{7}{10}$ to 1; which is the proportion I found between white marble and water: tho' it may perhaps be ſaid, that this blackneſs of colour proceeded not ſo much from any groſs, bituminous matter incorporated with that of the ſtone, as from ſome mineral ſmoke that had pervaded it.

The matter of medicinal ſtones may, whilſt fluid, receive virtues and a colour from ſubterraneous exhalations.

And it ſeems not impoſſible, that the matter which medicinal ſtones are made of, may, before it comes to be harden'd, derive various colours, and be endowed with virtues from ſubterraneal exhalations, and other ſteams. For that many parts of the lower earth emit copious exhalations into the upper, and even into the air itſelf, I preſume will be readily granted; that alſo ſuch ſubterraneal ſteams will eaſily mingle with liquors, and imbue them with their own qualities, may be inferr'd, from the experiment of mixing the ſcarce coagulable fumes of kindled and extinguiſhed brimſtone with wine and other liquors, which are thereby long preſerved; and that beneath the ſurface of the earth, there are ſulphureous and other ſteams, which may be plentifully mixed with water, and in all likelihood with petreſcent liquors, is with me beyond all queſtion.

That quick-ſilver may, in part, be reſolved into fumes by leſs fires than many of thoſe which burn under ground, will be readily acknowledged by chymiſts and gilders, and is obvious from the fumigations employed in the cure of the *Lues venerea*; and that mercury may in the bowels of the earth be ſo diſguiz'd and well mix'd with ſtony matter, as to ſuffer the whole concretion to paſs for ſtone, may be obſerved in ſome kinds of native cinnabar.

That ſal-armoniac will, with a moderate fire, be made to aſcend in form of exhalations, is vulgarly known, as to the factitious ſalt of that name; and I have found it to hold true in the native. That common ſal-armoniac, ſulphur, mercury, and tin, will ſublime into a gold-like ſubſtance, participating of moſt, if not all the ingredients, has appeared to me from a particular experiment. That even gold it ſelf may, with a ſmall addition, be made, by a moderate fire, to aſcend in the form of fumes or flame, I have ſeveral times tried. And, laſtly, that mineral exhalations may be met with in the bowels of the earth, is witneſſed by many credible perſons and eye-witneſſes, skilled in minerals. And this, ſome things that I my ſelf have ſeen, incline me to believe. Such an aſcent too, of mineral fumes, and even of metalline ones, may, alſo, be much confirm'd, not only by the writings of chymiſts, but by the learned and curious *Kentman*, who, in the uſeful catalogue of the *Miſnian* foſſils, reckons amongſt the *Pyritæ*, one whoſe title is *Pumicoſus*, and tinged of a black colour by a fiery exhalation; and another of a ſilver colour, tinged grey by a poiſonous exhalation. And the ſame may be farther confirm'd by a relation of the learned *Cabeus*, as to what he found in the territory of *Modena*.

Since then there are mineral exhalations of very different kinds, diſpers'd in many places under ground; and ſince there are ſeveral volatile minerals, as arſenic, orpiment, ſandarac, *&c.* that are very actively hurtful, there may others be endowed with medicinal qualities; and the exhalations of ſuch minerals, either alone, or mix'd with petreſcent liquors pervading duly diſpoſed earths, boles, or other fluid, ſoft, open ſubſtances, before their induration, may impregnate them with medicinal and other qualities.

And even when more ſolid.

Nay, when I recollect the odd phenomena, that I have partly obſerv'd, and partly received from credible teſtimony, about the coalitions, mixtures, tinctures, and their effects, in metalline, ſtony, and other foſſil concretions, I dare not peremptorily deny, that, even after ſubterraneal bodies have obtain'd a conſiderable degree of induration, and, perhaps, enough to make them paſs for ſtones, there may be ſubterraneal ſteams able to penetrate, tinge, and otherwiſe impregnate them; which ſeems the leſs incredible from what was juſt now related out of *Kentman*, and eſpecially from my own experiments, made to tinge native cryſtal with different colours, by the fumes of volatile minerals. And that a very ſmall proportion of a metalline ſubſtance, reſolv'd into minute particles, may impart a tincture to a great quantity of other matter, duly diſpoſed, appears from thoſe factitious gems, wherein, with three or four grains of a metal, skilfully calcined, or ſome mineral pigment, we can give the colour of a natural gem to a whole ounce or more, of a vitrified material. In more ſubtile fluids I have made the inſtance, vaſtly more conſpicuous, by tinging with one grain or leſs of a prepared metal, as gold or copper, as much phlegm, ſucceſſively generated, as would, if it could have been all preſerv'd, have amounted to a bulky quantity of deeply colour'd matter.

Some ingredients of opake gems, and medicinal ſtones, may before they received this form, have been complete minerals.

4. The laſt thing I ſhall produce to ſhew, that the virtues of opake gems and medicinal ſtones may be more eaſily, than thoſe of tranſparent ones, accounted for on our hypotheſis is, that the principal ingredients, whereof many ſuch opake ſtones conſiſt, were complete mine-

ral bodies before they were petrified; ſome of them having been medicinal boles, or the like earths; ſome earths abounding with metalline or mineral juices; ſome ores of metals or minerals of kin to metals; and ſome, in fine, bodies of other natures, differing from theſe and from one another. For all ſuch ſeveral kinds of foſſils may, by the ſupervention and pervaſion of petrific ſpirits, be turned into ſtone; and conſequently, retain many of the virtues they were endowed with by the mineral corpuſcles that had copiouſly impregnated them, whilſt they remained bodies of a more open or penetrable texture.

I might illuſtrate this from the methods whereby I made ſuch mixtures of ſtony and metalline ingredients, as notwithſtanding their coalition, were tranſparent; tho' that be more difficult than to compound ſuch concretions when they are deſigned to be opake. But here, again, I muſt obviate an objection, that may be made to the preſent argument. For ſince it ſeems, by our doctrine, that gems may be only magiſteries, and conſequently but ſuch compoſitions as, tho' made in the bowels of the earth, might be imitated by human ſkill; it may appear very improbable to many, that bodies, ſo near of kin to artificial ones, ſhould poſſeſs ſuch peculiar and ſtrange virtues as are aſcribed to ſeveral gems, and thought capable of flowing only from certain very noble ſubſtantial forms.

To this I might reply, that I admit not any ſuch imaginary beings, as the peripatetic forms, which, I believe, will never be demonſtrated to exiſt. But to avoid unneceſſary diſputes, I rather anſwer, in ſhort, that ſuch compoſitions as are called artificial, may, nevertheleſs, be endowed with great virtues, and ſuch as are called ſpecific; witneſs the virtues of many chymical preparations, even of thoſe that are uſed by phyſicians of all ſorts; nay, even *Galen* himſelf will furniſh us with inſtances to our preſent purpoſe. For to the aſhes of crawfiſh, which, notwithſtanding the deſtruction that has been made of their priſtine body by fire, he gives a greater commendation againſt the bite of a mad dog, than to the fiſh it ſelf unburn'd, or to any medicines of nature's providing: and a virtue of that kind and degree will ſurely be allowed ſpecific. And the *Theriaca*, tho' a factitious body, and conſiſting of a multitude of ingredients huddled together, was yet, in the days of *Galen*, eſteemed a moſt famous antidote; and has ſince been celebrated, not only for its alexipharmic virtues, which alone are ſufficient to entitle it to a ſpecific; but for many others, either upon account of its manifeſt or occult qualities.

Whence ſtones of the ſame kind have different qualifications.

But farther, according to our way of explaining the production of medicinal ſtones, a probable ſolution may be given of this difficult phenomenon, that, ſometimes, ſtones allow'd, without ſcruple, to be of the ſame kind, are of ſuch different qualifications, that ſome of them prove very conſiderable remedies in caſes where others are almoſt ineffectual. And I have, ſometimes, obſerved, that a medicinal ſtone may have virtues, ſuppoſed to be the properties of ſtones of another kind. For, according to our hypotheſis, when the ſtony matter is impregnated as it ought to be, with thoſe minerals that in the ordinary courſe of nature belong to its ſpecies, its virtue will be ſuch as it ſhould be for kind; but for degree may be very various, according to the quantity, purity, ſubtilty, *&c.* of the mineral that impregnates it. But if the ſtony matter chance to be imbued with ſome other ſubſtance of a contrary nature, tho' perhaps the proportion of it may be ſo ſmall, and the colour of it ſuch as not to render an alteration in the ſtone, obvious to ſenſe, and conſiderable enough to make it judg'd of another ſpecies; yet it may ſo vitiate the matter, wherein its quality reſides, or check and infringe its operation, as not to leave the ſtone any great degree of virtue. On the other ſide, if it happen that the mineral corpuſcles, which uſually impart a certain virtue to the ſtony matter of one gem, ſhould, by ſome lucky hit, be ſo united with that of another ſort, (of which I formerly gave an inſtance in green diamonds,) tho' the quantity of this unuſual ingredient may be but very ſmall; yet if its efficacy be great, it may ennoble the ſtone with a remarkable degree of ſome ſuch virtue, as is ſuppoſed not to belong to that ſpecies, but to another. Thus I have been told of ſurprizing virtues in a ſtone for the ſtanching of hemorrhages; tho' by its colour and texture I ſhould never have taken it for a blood-ſtone.

The ſubtilty and penetrating virtues of ſome liquors, if duly conſider'd, may ſhew it to be poſſible, that ſuch bodies ſhould be petrified by them, as in part conſiſt of animal and vegetable ſubſtances. Thus we ſee petrified ſhells, bones, and pieces of wood; and that ſoft ſtone, which is plentifully found near *Naples*, and commonly called *Lapis Lyncurius*, being rubb'd a little, moiſten'd with water, and then expoſed to the ſun, in a due ſeaſon of the year, will, in a very ſhort time, as eye-witneſſes have aſſured me, produce muſhrooms fit to be eaten; as if even the ſeminal principles and rudiments of vegetables may be ſo preſerv'd in a petrified earth, as to diſcloſe themſelves when they find an opportunity. And an eminent perſon, maſter of ſome of theſe ſtones, informs me, that they now and then find them of a vaſt bigneſs; as if whole maſſes of earth, pregnant with the prolific principles of muſhrooms, were, by ſome ſupervening petreſcent liquor, turned into ſtone.

Various earths may be petrified, and contain ſurprizing, ſubtile, and medicinal parts.

And not only boles, ſeal'd earths, and ſuch like foſſils, as are commonly known for medicinal, may be harden'd into ſtone by petrifying agents; but other earths, ſubject to petrifaction, may contain medicinal and ſubtile particles, of ſuch a kind as ſeems ſcarce credible. I have ſeen a clay-pit, wherein, at a conſiderable depth from the ſurface of the earth, there lay a bed of clay, which, by diſtillation, yielded a ſalt ſo volatile and ſtrong, and ſo different from other ſubterraneal ſalts, that I could not obſerve the manifeſt qualities of it without wonder; and the owners of the pit, who were rich and curious perſons, did themſelves uſe it for phyſic, and cried it up for an excellent cordial, a great opening and diaphoretic medicine.

Laſtly, that ſublimable ſalts, ſulphurs, and bitumens, may be met with in the bowels of the earth, is certain; and that ſuch ſubſtances may be found in bodies which paſs for ſtones, I have been induced to think, by the chymical examination I purpoſely made of ſome ſuch concretions; particularly of that ſolid and heavy one, commonly called *Scotch* coal; from whence I obtain'd, by diſtillation, a large proportion of oil, or liquid bitumen, and no ſmall number of ſaline particles, that ſeemed to be of an uncommon nature.

But enough of a ſubject, wherein, contrary to my cuſtom, I have indulged conjectures; which, however, are the more excuſable, in treating of the operations of nature in her dark and ſubterraneal receſſes; for here to have offered accounts that carry probability along with them, ſeems ſufficient.

OBSERVATIONS
UPON
DIAMONDS;
And particularly upon one which wou'd ſhine, remarkably, in the dark.

Promiſcuous obſervations upon diamonds.

DIamonds being generally eſteemed the moſt noble and precious of inanimate bodies, I cou'd not but gratifie my curioſity about them, by propoſing queſtions, whilſt a director of the *Engliſh Eaſt-India* company, to ſome *Eaſt-India* merchants and jewellers, who had dealt much with theſe gems.

And diamonds deſerve the rather to be enquired into, becauſe the commerce they help to maintain between the weſtern and eaſtern parts of the world, is very conſiderable. For as ſmall as their bulk is, their properties and mens opinion, ſo greatly recommend them, that, I remember, one of the moſt famous and intelligent merchants of this nation, aſſured me, that, according to his well-grounded eſtimate, there came of them from the *Eaſt-Indies* into *Europe*, one year with another, to the value of 350,000 *l. Sterl.* whereof about 100,000 *l.* came into *England*; which at preſent, by the prudent indulgence of the government, and of the *Eaſt-India* company, is become the mart of diamonds.

To prove the great hardneſs of diamonds, even in compariſon of other bodies, that are thought wonderfully hard, a famous artiſt for cutting of theſe ſtones affirm'd to me, that he could neither cut or poliſh diamonds with any thing but diamonds; and that if he ſhou'd employ ſo rough a way, and ſuch forcible engines to cut rubies, or any other ſtones, as he does to cut thoſe, it wou'd preſently break them in pieces; which, by the inſpection of his engine, appear'd very probable.

A very ſkilful cutter and poliſher of diamonds told me, that having dealt in them near twenty years at *Amſterdam*, and ſeveral years in *England*, he perceived there are of late brought over worſe ſorts of diamonds; ſo that he judges thoſe of the old rock (as he calls them) either to be quite ſpent in the *Indies*, or, at leaſt, to be ſeldom or never tranſported. And he finds ſeveral late diamonds, ſo ſoft and brittle, in compariſon of thoſe of the old rock, that he is often afraid, or unwilling to meddle with them, leſt he ſhould ſpoil them in the cutting or poliſhing.

Notwithſtanding the wonderful hardneſs of diamonds, there is no truth in the tradition, that repreſents them unable to be broken by any external force, unleſs firſt ſoften'd by being ſteep'd in the blood of a goat. This odd aſſertion, I find to be contradicted by the frequent practice of diamond-cutters: and particularly, having enquired of one of them, to whom abundance of thoſe gems are brought, to be fitted for the jeweller and goldſmith, he aſſur'd me, that he makes much of his powder to poliſh diamonds with, only by beating board diamonds (as they call them) in a ſteel or iron mortar; and that he has by this way made, with eaſe, ſome hundred carrats of diamond-duſt.

'Tis a received opinion among many who deal in gems, that as diamonds are the hardeſt of bodies, ſo the ſame compactneſs, and their great ſolidity, gives them alſo a proportionable gravity, and makes them extremely weighty with regard to their bulk.

But a rough diamond ſomewhat dark within, that in a pair of ſcales which turn'd with the 32^{d} part of a grain, weighed 8 grains, and $\frac{8}{16}$; being carefully weigh'd in water, according to the rules of hydroſtatics; it proved to an equal bulk of that liquor, as $2\frac{22}{23}$ to 1. So that, as far as can be judg'd by this trial, even a diamond weighs not thrice as much as water.

Asking a famous and experienced cutter of diamonds, whether he did not find ſome rough diamonds heavier than others of the ſame bigneſs? he told me, he did, eſpecially if ſome of them were cloudy or foul: and ſhewing me a diamond that ſeemed to be about the bigneſs of two ordinary peaſe, or leſs, he affirm'd, that he ſometimes found in diamonds of that ſize, compared together, about a carrat (or four grains) difference in point of weight.

The ſhape or figure of diamonds is not eaſie to be ſecurely determin'd. For thoſe that are ſeen in rings and other jewels, having been, by way of preparation, cut and poliſh'd, change their natural figures, for that which the artificer thinks fit to give them. And rough diamonds themſelves (which are not eaſily met with) often come to our hands broken, tho' undeſignedly, by the diggers; and are, therefore unfit to acquaint us with their genuine ſhape; which we may be unable to diſcover, becauſe of the accidents whereto the matter they conſiſted of was ſubject in the mine. For having had a parcel of between 100 and 150, put into my hands at one time, in the *Eaſt-India* houſe, I found very few of them completely ſhap'd; but generally broken, and of very irregular figures, like thoſe of ſo much gravel taken up at adventures upon the ſea-ſhore. But ſome few appeared pretty regularly figur'd, which, probably, were not much hinder'd from ſhooting freely in the wombs or cavities, wherein they coagulated or concreted. And theſe ſeem'd to conſiſt, in my opinion, of ſeveral triangular ſurfaces, that were terminated in, or compos'd ſeveral ſolid angles. And one rough diamond I had of my own, wherein this ſhape was more conſpicuous, than I remember to have ſeen in any other. Beſides, having enquired of a very experienced artificer, who fitted up theſe gems for the goldſmith, whether he found rough diamonds to be of any conſtant figure? he anſwered me, that he always obſerved thoſe which had any regular figure, to be ſix-corner'd.

Diamods have a grain, or a determinate tendency of their fibres, or rather of the thin plates they are made up of, as well as wood; and may, with eaſe, be ſplit along the grain, tho' not againſt it. I have ſeen a very large diamond, that was cut, with the grain, into three pieces, whereof the middlemoſt, tho' large, and about the thickneſs of a ſhilling, was evenly thick, and exactly flat on both ſides; and I poſſeſs a diamond-ring, whoſe ſtone I caus'd to be ſet rough, as nature produced it, becauſe in that ſtate the grain is manifeſt to the naked eye; (and much more when viewed thro' a glaſs, that moderately magnifies the ſeveral plates it conſiſts of) having their edges diſtinguiſhable like thoſe of a book a little open'd. An experienced cutter of theſe gems aſſured me, that one large blow may ſplit even great diamonds, if it be given, as they ſpeak, with the grain; but againſt the grain, he affirm'd to me, he is not able ſo much as to cut or poliſh them.

The common colour of diamonds being generally known by ſight, 'tis not neceſſary, nor wou'd it be eaſie to deſcribe it by words; but the moſt uſual colour of theſe gems is not the only one. A great traveller into the eaſtern parts of the world aſſured me, that he had ſeen ſome of them that were of a pale bluiſh colour. That famous *French* jeweller, Monſieur *Tavernier*, gives an account of a fair diamond that he had, of a very red colour; a great lady told me, ſhe was miſtreſs of a fair one, which, tho' not of a ruby, was of a red colour: and a relation of mine uſed to wear a diamond ring; which, tho' the ſtone was not great, he valued at a hundred pounds, becauſe its colour was of ſo fine a golden yellow, that I ſhould have taken it for an excellent topaz. And attentively ſurveying a parcel of rough diamonds, newly brought from the *Eaſt-Indies*, I perceived among them, beſides ſeveral lighter variations of colour, one ſtone, which was all green; and this to ſuch a degree, that I doubted not, if poliſhed and ſet, it might paſs for an excellent emerald. I ſhould have ſuſpected this gem to have been really of that kind, but that I found it among diamonds belonging to merchants, too skilful in thoſe gems to be impos'd upon; and, which was more, the ſtone being yet rough and uncut, I found it plainly to have the proper ſhape of a diamond.

At the late return of the ſhips from *India*, being preſent when the diamonds were delivered to their owners, I took particular notice of one belonging to a *Dutch* merchant, whoſe father was a cutter of diamonds, and bred him to the ſame trade. This diamond came from the kingdom of *Golconda*, it had ſix triangular ſides, which yet were neither regularly figured, nor truly flat; ſome of them being a little convex, and one of them having a manifeſt, and oddly-figured cavity in it. The ſtone was fair and flawleſs, and ſo thick, that the merchant told me, it would be too deep for one ring, and that, therefore, he meant to ſplit it in two: it weighed ten carrats. I could eaſily perceive the grain of this diamond, which the merchant alſo acknowledged; who ſaid, he had never ſeen in diamonds any heterogeneous mixture incloſed. He further inform'd me, that he received a large diamond from *Borneo*, that was much darker than one I ſhewed him; ſo that he compared it to ſoot; but when cut and poliſh'd, he and others were much ſurprized, to find it a fair and clear ſtone, of very great value.

That the real virtues of gems, may be probably deriv'd from the metalline, or mineral tinctures, or other corpuſcles that were imbody'd with the matter of the gem, whilſt it was yet fluid, or ſoft, and afterwards coagulated therewith, appears probable; becauſe having long ſuſpected, that the matter whereof diamonds principally conſiſt, was, whilſt yet *in ſolutis principiis*, impregnated with metalline, and more particularly with ferruginous particles; and finding again, ſome number of ſmall diamonds, that I had bought for experiments, I conſidered that their being yet rough, and ſo in their natural ſtate, might make them more fit for my purpoſe. They were alſo not ſo clear as thoſe that we value in rings, which, probably, argued their having more of a chalybeate tincture in them, than I ſhould expect in the more tranſparent. I, therefore, took a moderately vigorous load-ſtone, and apply'd it ſucceſſively to five or ſix of theſe ſmall ſtones, without perceiving it had any operation on them: but when I came to apply it to one, which looked ſomewhat duller than the reſt, I found that it had in it particles enow of a ferruginous nature, to make it magnetic; and obſerv'd that it would not only ſuffer it ſelf to be taken up by the ſtrongeſt pole of the load-ſtone, but when that pole was offer'd within a convenient diſtance, it would readily leap through the air to faſten it ſelf to it.

'Tis, on one ſide, taken for granted, that all glittering gems ſhine in the dark; and on the other, abſolutely deny'd, that any ſtone has that faculty. For my ſelf, I confeſs, I look upon Mr. *Clayton*'s diamond as a great rarity, becauſe of its ſhining by night.

Boetius de Boot, indeed, who is judg'd the beſt author upon the ſubject of gems, allows no ſuch virtue in diamonds, and peremptorily ſays, "no man ever durſt aver he had actually ſeen a ſtone that, of "it ſelf, afforded light." *Johannes de Laet*, alſo, thinks no inſtance of it can be produced. And *Olaus Wormius* ſeems to imagine it falſely reported even of the carbuncle. And, indeed, upon examining a moſt excellent ruby, I could not, by friction, bring it to afford the leaſt glimmering of light.

Whether gems are, of themſelves, luminous?

But tho' I am loth to admit ſtrange things for truth, yet I am not very forward to reject them as impoſſibilities; and therefore, would not diſcourage any from making farther inquiry, whether there be ſuch a thing as a true carbuncle, or ſtone, that, without rubbing, will ſhine in the dark? For if ſuch a thing can be found, it may afford no ſmall aſſiſtance in diſcovering the nature of light. *Vartomannus*, indeed, was not an eye-witneſs of what he relates, that the king of *Pegu* had a true carbuncle, of that bigneſs and ſplendor, as to ſhine very gloriouſly in the dark; and tho' *Garcias ab Horto*, the *Indian* vice-roy's phyſician, ſpeaks of another carbuncle only upon the report of one he diſcours'd with, who affirmed himſelf to have ſeen it; yet as we are not ſure that theſe pretended eye-witneſſes ſpeak true, they may have done ſo, for ought we know to the contrary. And I could produce a much more conſiderable teſtimony to the ſame purpoſe, if I had the permiſſion of the perſon. But I may ſay, that *Marcus Paulus Venetus*, whoſe ſuppoſed fables many of our later travellers and navigators have ſince found to be truths, ſpeaking of the king of *Zeilan*, tells us, he is ſaid to have the beſt ruby in the world, a palm long, and big as a man's arm, without ſpot, and ſhining like a fire. He adds, that the great *Cham* offer'd the value of a city for it; but the king anſwer'd, he would not exchange it for the treaſure of the world; becauſe it had deſcended to him from his anceſtors. And two *Ruſſian Coſſacks* relate, in the account of their journey to *Catray*, dedicated to their emperor, that they were told, the king of thoſe parts had a ſtone which gives light like the ſun, both day and night, and call'd, in their language, *Sarra*; which thoſe *Coſſacks* interpret a ruby. But theſe relations are too uncertain to build any thing upon. However, there arriv'd here about two years ſince, out of *America*, the governour of one of the principal colonies there, an ancient virtuoſo, and a member of the Royal Society, who, finding the chief affairs of his country committed to me and another, made me ſeveral viſits, and in one of them told me, the *Indians* had a tradition, that in a certain, almoſt inacceſſible hill, far up in the country, there was a ſtone, which, in the night time, ſhone very vividly to a great diſtance; and he aſſured me, that tho' he thought it not fit to venture

him

himſelf ſo far among thoſe ſavages, yet he purpoſely ſent a bold *Engliſhman* thither, with ſome natives for his guides; and that this meſſenger brought him back word, that at a diſtance from the hill he had plainly perceived ſuch a ſhining ſubſtance as the tradition implies; and ſlighting the ſuperſtitious fears of the inhabitants, with great difficulty, made a ſhift to clamber up to that part of the hill where, by a very careful obſervation, he ſuppos'd himſelf to have ſeen the light; but whether he had miſtaken the place, or for ſome other reaſon, he cou'd not find it there; tho' when he was return'd to his former ſtation, he again perceiv'd the light in the ſame place where it ſhone before. I reſerve to my ſelf a full liberty of believing no more of this relation than I ſee cauſe; yet I the leſs ſcruple to communicate it, becauſe it agrees, in great meaſure, with the following accounts. For tho' the learned authors, I formerly mentioned, think no writer has affirmed himſelf to have ſeen a real carbuncle; yet conſidering the light of Mr. *Clayton*'s diamond, it recall'd to my mind, that ſome years before I had met with an old *Italian* book, highly extoll'd by very competent judges, the author whereof is *Benvenuto Cellini*, who has a paſſage in it to this purpoſe. "In *Clement* the 7th's time, ſays he, I hap-
" pen'd to ſee a carbuncle at a certain *Raguſian* merchant's, named *Beigoio di*
" *Bona.* This was a white carbuncle of that vivid kind of paleneſs we ſee
" in a chalcedonian; but it had a ſurprizingly pleaſant luſtre, and ſhone
" in the dark, tho' not ſo much as colour'd carbuncles; however, in an ex-
" ceeding dark place, I ſaw it ſhine in the manner of fire almoſt extin-
" guiſhed. But as for colour'd carbuncles, it has not been my fortune
" to ſee any. But a *Roman* gentleman of great experience in jewels
" told me, that one *Jacopo Cola* being, by night, in a vineyard of his,
" and ſpying ſomething in the midſt of it that ſhone like a little
" glowing coal, at the foot of a vine, he went near the place where he
" thought he had ſeen the fire; but not finding it, he ſaid, that being
" returned to the ſame place whence he had firſt ſeen it, and percei-
" ving there the ſame ſplendor as before, he mark'd it ſo carefully,
" that at length he came to it, and took up a very little ſtone, which
" he carried away with tranſport. And the next day relating to ſome
" friends after what manner he had found it, a *Venetian* ambaſſador,
" very ſkilful in gems, happening to be preſent, knew it to be a car-
" buncle, and therefore ſubtilly, before he and the ſaid *Jacopo* part-
" ed, purchas'd it for ten crowns, and immediately left *Rome*, to avoid
" reſtoring it. He farther affirms, that this *Venetian* gentleman afterwards
" ſold it to the grand Seignior for a hundred thouſand crowns."

Here *Cellini* affirms himſelf to have ſeen a real carbuncle with his own eyes; and he appears to be very cautious in what he delivers; and is inclin'd rather to leſſen, than increaſe the wonder of it. This teſtimony is the more conſiderable; becauſe tho' *Cellini* was born a ſubject neither to the pope nor to the king of *France*, yet both thoſe princes employed him much about their nobleſt jewels. What is now report-

ed

Whether the turquoiſe ſtone may loſe its luſtre upon the ſickneſs or death of the perſon who wears it.

ed concerning a ſhining ſubſtance to be ſeen in one of the iſlands about *Scotland*, I leave to Sir *Robert Morray*, to whom the information was originally given. M. *Boreel*, an ingenious *Dutch* gentleman, whoſe father was long ambaſſador for the *Netherlands* in *England*, told me, he was acquainted with the admiral of the *Dutch* in the *Eaſt-Indies*, who aſſured him, that at his return from thence, he brought with him into *Holland* a ſtone, which, tho' it look'd but like a pale, dull diamond, ſuch as Mr. *Clayton*'s was, yet proved a real carbuncle, and did, without rubbing, ſhine ſo much, that when the admiral had occaſion to open a cheſt, which he kept under deck, in a dark place, it would immediately, by its native light, illuminate a great part thereof. I impatiently expect a more particular account of this ſtone from the admiral himſelf, who is ſtill alive in *Holland*; not only becauſe ſo unlikely a thing needs a clear evidence, but becauſe I have had ſome ſuſpicion that, ſuppoſing the truth of the thing, what may be a ſhining ſtone in a very hot country, as the *Eaſt-Indies*, may, perhaps, ceaſe to be ſo in one as cold as *Holland*. For in Mr. *Clayton*'s diamond, I obſerved, that a very moderate degree of warmth, without friction, would make it ſhine a little. And, I confeſs, this is not the only odd ſuſpicion my experiments upon that diamond have ſuggeſted to me. Nay, I begin to doubt whether it may not, in ſome caſes, be true, that the right turquoiſe will change colour as the wearer is ſick or well; and manifeſtly loſe its ſplendor at his death. For when I found, that even the warmth of a friction, that laſted not above a quarter of a minute, and even that of my body, whoſe conſtitution is none of the hotteſt, would make a manifeſt change in a diamond; it ſeem'd not impoſſible, that certain warm and ſaline exhalations, iſſuing from the body of a living man, may, ſome way or other, by their preſence or abſence, diverſify the colour and the ſplendor of ſo ſoft a ſtone as the turquoiſe *. 'Tis ſo very remarkable what the judicious lapidary, *Boetius de Boot* affirms of this ſtone, that the narrative of it ought not to be omitted. " I conſtantly wear a turquoiſe in a ring, ſays he, the " ſtrange property whereof I can never ſufficiently admire. Thirty " years ago 'twas worn by a *Spaniard*, and, after his death, expoſed to " ſale among the reſt of his goods; upon the report whereof, there " was a great concourſe of ſuch perſons as had formerly admired its " beauty, and among the reſt my father: but they were all ſurpriz'd " to find it quite ſully'd and faded; whence they conjectur'd it had " been chang'd for another: my father, however, bought it for a " very ſmall matter, but thought ſo meanly of it, that ſince, cry'd " he, 't's a common ſaying, that a turquoiſe muſt be made a preſent " of before it will diſplay its virtue, do you, my ſon, wear it; but

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* Turquoiſe ſtones are nothing but animal bones petrified, and a blue colour given them by fire. There are mines of them in *France*: and a large account is given of this matter in the *French* Memoirs. *A.* 1715. *p.* 230.

"thinking it too mean to wear without ſome ornament, I caus'd it to "be engraved, and made into a ſeal-ring; and before I had wore "it a month, its luſtre return'd; tho' it ſhone leſs bright on account "of the graving. This rais'd wonder in us all, and the more, becauſe "it improves in beauty every day; for which reaſon I never lay it "aſide, and ſtill continue to wear it."

This relation ſeems confirmed by the teſtimony of *Olaus Wormius*. And I my ſelf have ſeen a turquoiſe, worn in a ring, wherein there were ſome ſmall ſpots, which the perſon who owned it aſſured me, he had obſerv'd to grow ſometimes greater, ſometimes leſs; and to be ſometimes in one part of the ſtone, ſometimes in another. I deſired him to take pictures from time to time of the ſtone, and of the ſituation of the cloudy parts, that their motion might thence be more indiſputable, and the better obſerv'd; he afterwards aſſured me, he had thus drawn ſchemes, whereby the ſeveral removes and motions of the clouds are very manifeſt; tho' the cauſe ſeemed to him very obſcure. Theſe pictures he has promis'd to ſhew me, and is very ready to put the ſtone it ſelf into my hands; but the ring having ſince been caſually broken upon his finger, unleſs the ſtone can be taken out, and ſet again without any conſiderable heat, he is unwilling to have it meddled with, for fear its peculiarity ſhould be thereby deſtroyed. And, poſſibly, his apprehenſion would have been ſtrengthened, if I had told him what is related by the learned *Wormius*, of an acquaintance of his, who had a nephritic ſtone, the eminent virtues whereof he often experienced; and for that reaſon wore it ſtill about his wriſt. But going into a bath of water wherein certain herbs had been boiled, the ſtone, by being wetted with the decoction, was deprived of all its virtue. And we might expect to find turquoiſes, likewiſe, eaſie to be wrought upon in point of colour, if it be true, which the curious *Antonio Neri* ſays; that when diſcoloured and grown white, they will again acquire an excellent colour, if kept two or three days cover'd with oil of ſweet almonds, ſtanding in warm aſhes. But I could not ſatisfie my ſelf herein, becauſe the moſt skilful perſons, among whom I have enquired for turquoiſes, aſſure me, that the true ones are great rarities. 'Tis, however, remarkable, that the ſtone called *Oculus mundi*, if it be good in its kind, will have ſo great a change made in its texture, by being barely left a while in common water, that from opake, it becomes tranſparent; and acquires a luſtre, of which it will be again deprived, without any art or violence, by leaving it a while in the air. But before experience had ſatisfied us of the truth hereof, it ſeemed as unlikely, that common water, or air, ſhould work ſuch great changes in that gem, as now that the effluvia of a human body ſhould produce leſs changes in a turquoiſe.

But to come to the obſervations we made on Mr. *Clayton's* diamond.

12. This

Obſervations upon a diamond that would ſhine remarkably, in the dark.

1. This was a table diamond, about a third of an inch in length, and ſomewhat leſs in breadth; a dull ſtone, of a very bad water; having in the day time very little of the vividneſs of ordinary diamonds, and being blemiſhed with a whitiſh cloud about the middle, which covered near a third of the ſtone. 2. Nothing remarkable appeared in any part of it, when examined with a microſcope; but view'd in the day time, in a bed, with the curtains carefully drawn, I could not diſcern it to ſhine at all, tho' well rubb'd; but about a little after ſun-ſet, whilſt the twilight yet laſted; and in the morning, a pretty while after ſun-riſing, I could, after a light friction, eaſily perceive it to ſhine. 3. The candles being remov'd, I could not, in a dark place, diſcern the ſtone to have any light when I looked on it, without having rubb'd, or otherwiſe prepared it. 4. Neither by two white pebbles, hard rubb'd one againſt the other, by the long and vehement friction of rock cryſtal, againſt a piece of red cloth; nor by rubbing two diamonds ſet in rings, as I had rubb'd this ſtone, could I produce any ſenſible degree of light. 5. I found this diamond hard enough not only to write readily upon glaſs, but to grave on rock-cryſtal it ſelf. 6. I found this to have, like other diamonds, an electrical virtue; for it wou'd attract light bodies, as amber, jet, *&c.* tho' in a leſs degree. 7. Being rubb'd upon my cloaths, as is uſual, to excite amber, wax, and other electrical bodies; it did, in the dark, manifeſtly ſhine like rotten wood, the ſcales of whitings, or other putrefied fiſh. 8. But this light was fainter than that of the ſcales and ſlime of whitings, and much fainter than the light of a glow-worm; by which I have ſometimes been able to read a ſhort word; but after an ordinary friction of this diamond, I cou'd not diſtinctly diſcern any of the neareſt bodies by the light of it. This glimmering, alſo, very conſiderably decay'd, immediately upon ceaſing the friction; tho' the ſtone continued viſible for ſome time after. 9. But if it were briskly rubb'd upon a convenient body for a pretty while, I found the light would be, for ſome moments, much more conſiderable, almoſt like the light of a glow-worm; ſo that, after I had ceas'd rubbing, I cou'd, with the chafed ſtone, exhibit a little luminous circle, faintly reſembling that made by the motion of a ſtick fired at one end; and thus it wou'd continue viſible, about ſeven or eight times as long as the preceding friction laſted. 10. I found, that holding it a while near the flame of a candle, with my eyes turn'd a contrary way, and immediately removing it into the dark, it diſclos'd ſome faint glimmering, but inferior to that acquired by rubbing. And afterwards holding it near a fire, that had but little flame, it was rather leſs excited thereby, than by a candle. 11. I, likewiſe, endeavoured to make it ſhine, by holding it for a pretty while in a very dark place, over a thick piece of iron, that was well heated, but not to that degree as to be viſible. And tho' at length I found the ſtone hence acquired ſome glimmering,

yet it was leſs than it gain'd by either of the other ways juſt mentioned. 12. I alſo brought it to ſome glimmering kind of light, by taking it into bed, and holding it a good while upon a warm part of my naked body. 13. To ſatisfy my ſelf, whether the motion introduced into the ſtone, generated the light upon account of its producing heat there; I held it near the flame of a candle, till it was qualified to ſhine pretty well in the dark; and then immediately apply'd a ſlender hair, to try whether it would attract it; but found not that it did. And for further confirmation, I once purpoſely kept it ſo near the hot iron, lately mentioned, as to make it ſenſibly warm; yet it ſhone more dimly than it had done by means of friction, or the flame of a candle; tho' by both thoſe ways it acquired not any ſenſible warmth. 14. Having purpoſely rubb'd it upon ſeveral bodies, different both in colour and in texture, there ſeemed to be ſome little difference in the excitation of the light. Upon white and red cloth it ſeemed to ſucceed beſt, eſpecially in compariſon of black. 15. But to try what it would do when rubb'd upon bodies more hard, and leſs apt to afford heat upon a light friction, than cloth, I firſt chafed it upon a white wooden box, by which it was excited; and afterwards upon a piece of earth purely glaz'd; which ſeemed, during the attrition, to make it ſhine better than any of the other bodies, without excepting the white ones; ſo that the effect cannot be aſcribed to the greater diſpoſition white bodies have to reflect light. 16. Having well excited the ſtone, I ſuddenly plung'd it under water, provided for that purpoſe; and perceived it to ſhine whilſt it was beneath the ſurface of the liquor; and this I did ſeveral times. But when I endeavoured to produce a light, by rubbing it upon the box lately mentioned, while both the ſtone and it were held beneath the ſurface of the water, I did not well ſatisfie my ſelf in the event of the trial: but this I found, that if I took the ſtone out, and rubb'd it upon a piece of cloth, it would, as uſual, preſently yield a light; tho' it required to be rubb'd much longer, before the deſired effect was produced. We likewiſe plunged it, after we had excited it, in liquors of ſeveral ſorts, as ſpirit of wine, oil, both chymical and expreſs'd, an acid ſpirit, and an alkaline ſolution; but found not any of thoſe various liquors to deſtroy its ſhining property. 17. I alſo ſeveral times try'd, that by covering it with ſpittle, it did not loſe its light. And having found by this obſervation, that a warm liquor would not extinguiſh light in the diamond, I thought fit to try, whether, by reaſon of its warmth, it would not excite it; and found, that if it were kept in warm water, till that had communicated its heat thereto, it would frequently ſhine as ſoon as taken out; and, probably, we ſhould have ſeen it ſhine more, whilſt it remained in the water, if ſome degree of opacity, which heated water acquires, upon account of the numerous little bubbles generated in it, had not kept us from diſcerning the luſtre of the ſtone. 18. Finding that by rubbing the ſtone with the flat ſide downwards, I loſt, by reaſon of the opacity of the ring, and the ſudden decay of light, upon the ceſſation of the attrition, the ſight of the ſtones greateſt vividneſs; and ſuppoſing that the commotion made in one part of the ſtone, would be eaſily propagated all over, I ſometimes held the piece of cloth, upon which I rubb'd it, ſo, that one ſide of the ſtone was expos'd to my eye, whilſt I chafed the other; whereby it appeared more vivid than formerly, and to make luminous tracts by its motions backward and forward. And, ſometimes, holding the ſtone upwards, I rubb'd its broad ſide with a fine ſmooth piece of tranſparent horn; by which means the light thro' that diaphanous ſubſtance appeared ſo brisk, whilſt I was actually rubbing the ſtone, that ſometimes, in ſome places, it ſeem'd to give little ſparks of fire. 19. I took alſo a piece of flat, blue glaſs, and having rubb'd the diamond well upon a cloth, and ſuddenly covered it with that glaſs, to try whether, in caſe the light could penetrate thro', it would, by appearing green, or of ſome other colour than blue, aſſiſt me to gueſs, whether it were ſimple or no. But finding the glaſs impervious to ſo faint a light, I thought fit to try, whether hard bodies would not, by attrition, aſſiſt the diamond's light, ſo as to become penetrable thereby. And, accordingly, when I rubb'd the glaſs briskly upon the ſtone, I found the light to be conſpicuous, and ſomewhat dyed in its paſſage; but could not eaſily give a name to the colour it exhibited. 20. Laſtly, ſuſpecting, upon the whole, that the principal, manifeſt change wrought in the ſtone; was by a compreſſure of its parts, rather than a heat; I found, that if I preſs'd the ſtone hard againſt a piece of white, well-glaz'd tile, it ſeemed, tho' I did not rub it, to ſhine at the ſides; but it ſhone very manifeſtly and vigorouſly, if, whilſt I thus preſs'd, I moved it any way upon the ſurface of the tile; tho' it drew not a line above a quarter of an inch long thereon; and tho' I only made it move from one end of that ſhort line to the other, without any return, or lateral motion: nay, after it had been often rubb'd, and ſuffered to loſe its light again, it not only ſeemed more eaſie to be excited than at firſt; but if I preſs'd hard upon it with my finger, at the very inſtant that I drew it briskly off the ſtone, it would give a very vivid, but exceeding ſhort-liv'd ſplendor or little coruſcation. And preſſing the point of a ſteel bodkin, hard againſt the ſurface of the diamond, but much more if I ſtruck the point againſt it, the coruſcation would be extremely ſudden, and very vivid, tho' very vaniſhing too; and this way, which commonly greatly ſurprized and delighted the ſpectators, ſeemed far more proper than the other, to ſhew that preſſure alone, if forcible enough, tho' it were ſo ſudden and ſhort, that it could not well be ſuppos'd to give the ſtone any thing near ſo ſenſible a degree of warmth, as may be ſuſpected in friction, is yet ſufficient to generate a very vivid light.

So many particulars obſerv'd in one night, may make this ſtone appear a kind of prodigy; but upon further trial with my own diamonds, by means of ſuch a briſk and aſſiduous friction, as might ballance the diſadvantages under which they laboured, in compariſon of Mr. *Clayton*'s, I found that I could eaſily bring a diamond I wore on my finger, to yield a ſenſible light; and it continued ſo to do, tho' I covered it with ſpittle, and uſed ſome other means of examination.

We afterwards tried rubies, ſapphires, emeralds, *&c.* but found none of them to ſhine, except ſome diamonds; and of theſe we were not able to ſay beforehand, which would be brought to ſhine, and which would not; for ſeveral very good diamonds would either give no light at all, or much leſs than others, that were far inferior to them. And yet 'tis a miſtake to think, a diamond muſt be foul and cloudy, as Mr. *Clayton*'s was, to ſhine; for as we could bring ſome ſuch to afford a glimmering light, ſo ſome clear and excellent diamonds did the like. But none of thoſe many that we try'd of all kinds, were equal to Mr. *Clayton*'s; not only for the degree of light it afforded, but the eaſineſs wherewith it was excited, and the comparatively great duration of its ſplendor.

And this may leſſen our wonder at the preceding obſervations, by ſhewing, that ſuch ſtrange properties are not peculiar to one diamond, but may be found in others alſo, and perhaps in ſeveral hard diaphanous ſtones *. But what this diſcovery takes off from the ſurprize of theſe phenomena, I hope it will add to the uſefulneſs of them, in diſcovering the nature of light. To which purpoſe we will here add ſome other experiments and obſervations.

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* "By rubbing a well-poliſhed piece " of amber, (ſaith Dr. *Wall*,) with my " hand, in the dark, it produced a " light; and drawing a long taper piece " of it thro' a woollen cloth, and " ſqueezing it hard, a prodigious number " of little cracklings were heard; " and every one of thoſe produced a " little flaſh of light; and if the amber " was only drawn gently thro' the cloth, " it produced a light, but no crackling; " and the light, upon its eruption, ſtrikes " the finger very ſenſibly, if held near " it, with a puff, like wind." The Dr. adds, "that the beſt time of making " the experiment is, when the ſun is " 18° below the horizon; when, tho' " the moon ſhines ever ſo bright, the " light is the ſame as in the darkeſt " room. And as diamonds (continues " the ſame ingenious gentleman,) are " electrical as well as amber; I have " made ſome trials upon them, and think " my way of diſtinguiſhing diamonds " morally certain. A diamond, by an " eaſy ſlight friction in the dark with " the finger, woollen, or any ſoft animal " ſubſtance, appears in its whole body " to be luminous; nay, if you keep " rubbing for a while, and then expoſe " the ſtone to the eye, 'twill continue luminous " for ſome little time. But if " while the the ſun is 18° degrees below " the horizon, any one holds up a piece " of flannel ſtretched tight, at ſome diſtance " from the eye; and another " briſkly rubs the flannel hard with a " diamond on the other ſide; the light " to the eye of him who holds it, ſeems

NAT. HIST.

The light of rotten wood extinguiſhed in vacuo.

1. *Octob.* 29. 1667. Having procured a piece of ſhining wood, about the bigneſs of a groat or leſs, that gave a vivid light; we put it into a middle-ſized receiver, ſo that it was kept from touching the cement; and the pump being ſet a-work, we obſerved not, during the firſt five or ſix exſuctions of the air, that the ſplendor of the included wood was manifeſtly leſſened; though it was never at all increaſed; but about the ſeventh ſuck, it ſeem'd to grow a little more dim, and afterwards anſwered our expectation by loſing of its light more and more, as the air was pumped out; till about the tenth exſuction (tho' by the removal of the candles out of the room, and by black cloaths, *&c.* we made the place as dark as poſſible) we could not perceive any light at all to proceed from the wood.

2. Wherefore we let in the outward air, by degrees, and had the pleaſure to ſee the ſeemingly extinguiſh'd light revive ſo faſt and perfectly, that it looked almoſt like a little flaſh of lightning, and the ſplendor of the wood ſeemed rather greater, than before it was put into the receiver.

But for greater certainty, and to enjoy ſo delightful a ſpectacle, we repeated the experiment with the like ſucceſs as at firſt. Wherefore being deſirous to ſee how ſoon theſe changes might be produced, we included the wood into a very ſmall receiver of clear glaſs, and found, that in this the light would begin to grow faint at the ſecond, or at leaſt at the third exſuction of the air, and at the 6th or 7th quite diſappear. And we found, by a minute-watch, that the ſending the candles out of the room, the pumping out the air till the wood would ſhine no more, the re-admitting of the air (upon which it would in a trice recover its light) and the ſending in for the candles to conſult the watch, did in all take up but ſix minutes.

3. Having exhauſted this new receiver, till the wood quite diſappeared, we ſtayed ſomewhat above a quarter of an hour in the dark, without perceiving that it had regained any thing of light; though about the end of this time, we made the place about it as dark as we could; and then (it being too late at night to protract the experiment,) we let in the air, upon whoſe admiſſion the wood

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" much more pleaſant and perfect than
" in any other way I have yet tried. But
" what is ſtill more ſtrange, a diamond
" being expoſed in the open air to the
" sky, gives almoſt the ſame light with-
" out rubbing, as if rubbed in a dark
" room; and if in the open air you any
" way hinder its communication with
" the sky, it yields no light. I have tri-
" ed all or moſt of the other precious
" ſtones, but could find no ſuch pheno-
" menon in any of them. My experi-
" ments were made at the latter end of
" *May*, and the beginning of *June*; ſo that
" I pretend not to account for the pheno-
" mena of experiments made when the
" ſun is on the other ſide of the equator.
" —— I am well aſſured, that all, or moſt
" of the bodies which have an electricity,
" yield light by friction." See *Philoſ. Tranſ. No*: 314.

preſently recovered light enough to be conſpicuous at a diſtance, tho' it ſeemed to me ſomewhat leſs vivid than before; which yet may be owing either to a weakneſs in my ſight, or an effect of the ſteams of the cement, unfriendly, perhaps, to the luminouſneſs of the wood.

The night following we put in a piece of wood bigger than the former, being above an inch long, and this ſhone very vigorouſly; and having by a few ſucks quite deprived it of light, we left it in the exhauſted receiver for full half an hour; and then coming into the dark room again, we found all had not continued ſo ſtanch, but that ſome air had inſinuated it ſelf into the receiver. This we concluded to be but a ſmall portion of air, becauſe the wood was barely viſible to an attentive eye: and yet, that it was really ſome air got in, that cauſed the little glimmering light we perceived, may appear by this, that it preſently vaniſh'd at the firſt or ſecond ſuck; and then the air being let into the dark receiver, the included wood preſently ſhone again, as before; tho' I ſuſpected that I diſcerned ſome little diminution of its brightneſs; which yet, 'till further trials of the like kind, and for a longer time, have been made, I dare not affirm.

4. Having obſerved, on another occaſion, that ſometimes the operation, which the withdrawing of the air hath upon a body included in the receiver, proves more conſiderable ſome minutes after we ceaſed pumping, than immediately upon leaving off that exerciſe; I imagined, that even in ſuch caſes, where the light is not made wholly to diſappear by the emptying of the pneumatical glaſs, the ſuffering the body to remain a while there, tho' without any pumping (unleſs now and then a very little to remove the air, that might have inſinuated in the mean time) the remaining light of the body might, probably, be further impaired, if not reduced quite to vaniſh. To examine this conjecture, we put in a body that was not wood, which had ſome parts much more luminous than the reſt; and having drawn out the air, all the others diſappeared, and even the formerly brighter ones ſhone but faintly, when the pneumatical glaſs ſeemed to be exhauſted. But keeping the included body a while in that unfriendly place, we perceived the parts that had retained light, to grow more and more dim, ſome of them diſappearing, and that which was formerly the moſt conſpicuous, being now but juſt viſible to an attentive eye, and that ſcarce without diſpute; for if we had not known beforehand, that a ſhining matter had been included in the receiver, perhaps we ſhould not have found it out. And he who had the youngeſt eyes in the company, could not at all diſcern it; but the air being let in, the body began to ſhine again.

5. The rarifaction, or expanſion of the air, having ſo notable an operation upon our ſhining wood, I thought it would not be amiſs to try, what the compreſſion of the air would do to it: For which purpoſe we included a piece of it in ſuch a little inſtrument, or

condenſor, as was deviſed and propoſed by Mr. *Hook*. But tho' we impell'd the air forcibly into the glaſs, yet by reaſon of the thickneſs requiſite in ſuch glaſſes, and the opacity thence ariſing, we were not able to determine, whether any change was made in the luminouſneſs of the wood. Which I thought the leſs ſtrange, becauſe, by ſome experiments purpoſely deviſed, I had long ſince obſerved, that even a great preſſure from a fluid body, which preſſeth more uniformly againſt all the parts it toucheth of the conſiſtent body, works a far leſs manifeſt change, even on ſoft or tender ſubſtances, than one would expect from the force wherewith it compreſſeth.

6. Thinking fit to try, whether a ſmall quantity of air, without being ventilated or renewed, might not ſuffice to maintain this cold fire, though it will not that of a live coal, or a piece of match; we cauſed a piece of ſhining wood to be hermetically ſealed up in a pipe of clear and thin glaſs; but though carrying it into the dark, we found it had quite loſt its light, yet imagining that this might proceed from its having been over-heated (being ſealed up in a pipe not long enough to afford it a due diſtance from the flame of the lamp we employed to ſeal it) we cauſed two or three pieces of freſh wood, amounting, all of them, to the length of about two inches, to be ſealed up in a ſlender pipe, between four or five inches long; which being warily done, the wood retained its light very well, when the operation was over; and afterwards laying it by my bed-ſide, when the candles were carried out of the room, I conſidered it a while before I went to ſleep, and found it to ſhine vividly.

The next morning when I awaked, though the ſun was riſen, yet forbearing to draw open the curtains of my bed, till I had looked upon the ſealed glaſs, which I had fenced with a piece of cloth held between it and the window; my eyes having not yet been expoſed to the day-light, ſince the darkneſs they were accuſtomed to during the night, made me think the wood ſhone brighter than ever. And at night, after ten of the clock, looking on it in a dark place, it appeared luminous in all its length, though not ſo much as in the morning.

The morning after, and the night after that, the ſame wood did likewiſe manifeſtly, though not vigorouſly, ſhine; eſpecially one piece, whoſe light was much more vivid than the reſt: and, for ought I know, I might have obſerved them to ſhine longer, if one of the ſealed ends of the glaſs had not been accidentally broken.

7. I cauſed a piece of iron to be forged, whoſe top was of the bigneſs of a nutmeg; the reſt being a ſtem, of an inch, or an inch and a half long, for which we provided a little candleſtick of tobacco-pipe clay, that would not yield any ſmoak to fill and darken the receiver. Then having heated the iron red-hot, and placed it in this

clay, ſo that the round part was clearly protuberant, we conveyed it into a receiver of white glaſs, which was ſo placed, as to keep the ſides at as great a diſtance as we could from the iron, leſt the exceſſive heat ſhould (as we much feared it would) break the glaſs. Then ſending away the candles, and making the room dark, we haſtily pumped out the air; but could not perceive the withdrawing of it had any operation on the glowing iron. And though it continued ſhining long enough, to give us an opportunity to pump out, and let in the air, three ſeveral times; yet we could not obſerve, that the air had any manifeſt operation one way or other: for though, upon the withdrawing thereof, the iron grew dimmer and dimmer, yet that I attributed to the cooling of it; and the rather, becauſe having (to examine the conjecture) let in the air two or three times, when the receiver had been exhauſted, there appeared no manifeſt increaſe of light upon the ſudden admiſſion of it.

8. Some curious perſons would, perhaps, if they had been preſent, have deſired to ſee, whether a ſmall piece of ſhining wood, being ſo included in the receiver, that the pumping out of the air ſhould have no injurious operation upon the ſubſtance, its light would, upon the withdrawing of the air, be manifeſtly diminiſhed. This I was the leſs backward to try, becauſe it did not readily occur to me, that by any manifeſt experiment it appeared, that a body more thin than air, will, or can tranſmit light, as well as other diaphanous mediums. Wherefore having hermetically ſealed up a piece of ſhining wood in a ſlender pipe, and placed it in a ſmall receiver, that was likewiſe made of clear glaſs, we exhauſted it of air, and afterwards let in again that which we had excluded. But by neither of the operations could we perceive any ſenſible decreaſe, or increaſe, of the light of the wood; though by that very obſervation it appeared, that the glaſs had been well ſealed, ſince otherwiſe the included air would have got out of the pipe into the receiver, and have left the wood without light.

9. I took an old, thin glaſs, ſealed at one end, whoſe ſhape was pretty cylindrical; whoſe bore was about the bigneſs of a man's little finger, and whoſe length was about a foot or more. Into this pipe, near the ſealed end, we put a piece of ſhining wood, wedged in with a piece of cork, to keep it from falling; and having inverted the noſe of it into another ſlender glaſs, but not cylindrical, wherein was pretty ſtore of quick-ſilver; we put them both into a long receiver, ſhaped almoſt like a glaſs churn, and having pumped a while, that the air included in the pipe expanding it ſelf, might depreſs the quick-ſilver, and ſo make eſcapes into the receiver as long as we thought fit; we then let in the outward air, that the ſtagnant quick-ſilver might be impelled into the cavity of the pipe, now freed from much of the air, to the height requiſite for our purpoſe.

This done, we plied the pump again, and obſerved, that as the air in the pipe did, by its own ſpring, expand it ſelf more and more, and grow thinner and thinner, the ſhining wood grew dimmer and dimmer, till at length it ceaſed to ſhine; the internal air being then got much lower than the ſurface of the external quick-ſilver; whereupon opening the commerce between the cavity of the receiver, and the atmoſphere, the quick-ſilver was driven up again, and conſequently the air above it was reſtored to its former denſity; upon which the rotten wood alſo recovered its light. What the greateſt expanſion of this air was, we could not certainly determine, becauſe it raiſed the external quick-ſilver ſo high, as to hinder us from ſeeing and meaſuring it: but we gueſſed, that the air reached to about a foot or more, from the top of the pipe, to the ſurface of the quick-ſilver, near the bottom thereof. But when that rarified air was impelled into its former dimenſions, we meaſured it, and found, that the upper part of the tube, unpoſſeſs'd by the quick-ſilver, was about three inches; and the wood being about an inch long, there remained two inches, or ſomewhat better, for the air. But this experiment ought to be repeated, when exacter inſtruments can be procured.

Shining fiſh in vacuo.

10. Thinking it fit to try, as well, whether putrid fiſh that ſhines, be of the ſame nature, as to luminouſneſs, with rotten wood that ſhines too; as, whether the withdrawing of the air will extinguiſh or eclipſe the light of a conſiderable bulk of luminous matter, as in the experiments hitherto made, we found it would do to a ſmall one: we took a fiſh, that we had kept, and caus'd to be watched, till it was almoſt all over luminous; though much more in the belly, and ſome parts of the head, than elſewhere; and having ſuſpended it in a conveniently ſhaped receiver, we found it to give ſo great a light, that we ſuſpected before hand, that the withdrawing of the air would hardly have its full operation upon a body, whoſe bulk was conſiderable, as well as its light very vivid, and which had many luminous parts retired to a pretty diſtance from the air. Accordingly, having exhauſted the receiver, as much as uſual, it appear'd indeed, eſpecially towards the latter end of the operation, that the abſence of the air did conſiderably leſſen, and in ſome places eclipſe, the light of thoſe parts that ſhone leſs ſtrongly: but the belly appeared not much leſs luminous than before. Wherefore ſuppoſing, that upon turning of the ſtop-cock, the air coming in much more haſtily than it could be drawn out, we ſhould have the beſt advantage to diſcern, what intereſt it had in the luminouſneſs of the fiſh, we re-admitted it; and upon its ruſhing in, perceived the light to be, as it were, revived and increaſed; thoſe parts of the fiſh that were ſcarce viſible before, or ſhone but dimly, recovering preſently their former ſplendor.

And not to leave unproſecuted the remaining part of the experiment, which was to try, whether the kind of the luminous body, or only the greatneſs of the bulk, and the vividneſs of light, and, if I may ſo ſpeak, the tenacity of the ſubſtance it reſided in, made the difference between the fiſh and the wood; we put part of the fiſh of another kind, that ſhone much more faintly than that hitherto ſpoken of, and but in ſome places; and by the withdrawing the air, we made ſome of the luminous parts diſappear, and the others ſo dim, as ſcarce to be diſcerned; and yet both the one and the other regained their former light upon the return of the air.

And to purſue the experiment a little further, we put in ſuch a piece of the firſt fiſh, as though it were bright, was yet but thin, and not conſiderably broad; and upon pumping out the air, we found it, according to our expectation, quite eclipſed, though it recovered its light upon the air's re-entry.

'Tis probable, that ſome will make uſe of this diſcovery to countenance their opinion, that notwithſtanding the coldneſs (at leaſt as to ſenſe) of fiſhes, and other animals, there may be in the heart and blood a vital kind of fire, that needs air, as well as thoſe fires which are ſenſibly hot: which may leſſen the wonder, that animals ſhould not be able to live when robb'd of air.

11. To examine the conjecture mentioned in the laſt experiment, that the durableneſs of the light in the ſhining fiſh, in ſpite of the withdrawing the air, might proceed in great part from the vividneſs of it, and the tenacity of the matter it reſided in, rather than from the extent of the luminous body, in compariſon of the ſmall pieces of ſhining wood, I had hitherto made my trials with; in *Dec.* 1667. I got a large piece of wood, whoſe luminous ſuperficies might be, perhaps, ten or twelve times as great as that, which the eye ſaw, at once, of the ſurface of ſuch fragments of ſhining wood, as I uſed to employ. And though ſome parts of this large ſuperficies ſhone vividly enough for rotten wood, (for the light was uſually inferiour to that of our fiſh) yet this great piece being put into a convenient receiver, was, upon the withdrawing of the air, deprived of light, as the ſmaller ones had been formerly; the returning air reſtoring its light to the one, as it had done to the other.

12. I took ſome ſmall pieces of rotten fiſh, that ſhone ſome of them more faintly, and ſome of them more vividly than one another, but none ſo ſtrongly as ſome that I could have employed; and having in a very ſmall and clear receiver ſo far drawn away the air, as to make the included bodies diſappear, we ſo ordered the matter, that we kept out the air for about 24 hours; and then allowing it to re-enter, in a dark place and late at night, upon its firſt admittance they regained their light.

13. This,

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13. This, compared with ſome of my former obſervations about putrefaction, put me upon a trial, which, though it miſcarried, I ſhall here make mention of, that in caſe thoſe, who are better furniſhed with glaſſes, think it worth while, they may repeat it. Conſidering how great an intereſt putrefaction hath in the ſhining of fiſhes, and air in the phenomena of putrefaction, I thought it might be ſomewhat to the purpoſe, to take a fiſh, that was, according to the common courſe I had obſerved in animals, not far from the ſtate, at which it would begin to ſhine; and having cut out a piece of it, I cauſed the reſt to be hung up again in a cellar, and the piece to be put into a ſmall and tranſparent receiver, that we might obſerve, if in a day or two, or more, after the fiſh in the cellar ſhould begin to ſhine, that in the exhauſted receiver would alſo ſhine; or, becauſe that ſeem'd not likely, would, notwithſtanding the check which the abſence of the air might be preſumed to give the putrefaction, be found to ſhine too, either immediately upon the admiſſion of the air, or not long after.

But this experiment was only deſigned and attempted, not compleated; the receiver being ſo thin, that upon the exhauſtion of the internal air, the weight of the external broke it; and we could ill ſpare another of that kind from trials, we were more concern'd to make: notwithſtanding which, we made one trial more, which ſucceeded no better than the former, but miſcarried upon a quite differing account, *viz.* becauſe neither the included piece of fiſh, nor the remaining, though it were of the ſame ſort with the fiſhes I uſually employed, would ſhine at all, though kept a pretty while beyond the time, at which ſuch fiſhes uſually grew luminous.

And I will not undertake, that all the experiments another ſhall make with rotten fiſh, ſhall have juſt the ſame ſucceſs with theſe I have related. For, as I elſewhere obſerve, that the event of other experiments is not always certain; ſo I have had occaſion to obſerve the like about the ſhining of fiſhes. And I remember, that having once deſigned to make obſervations about the light of rotten fiſhes, and having, in order thereto, caus'd a competent number of them to be bought, not one of them all would ſhine; though they were bought by the ſame perſon I uſed to employ, and hung up in the ſame place, where I uſed to have them put; and kept not only till they began to putrefy, but beyond the time whereat others uſed to continue to ſhine; yet a parcel of the ſame kind of fiſhes, bought the week before, and another of the ſame kind, bought not many days after, ſhone according to expectation. What the reaſon of this diſappointment was, I could not determine; only I remember, that at the time it happened, the weather was variable, and not without ſome days of froſt and ſnow.

Notice muſt alſo be taken in making experiments with ſhining fiſh, that their luminouſneſs ſeldom continues very many days. This advertiſement may be therefore uſeful, becauſe without it we may be apt ſometimes to make trials, that cannot be ſoon enough brought to an iſſue; and ſo we may miſtake the loſs of light in the fiſh, to be a deprivation of it cauſed by the experiment; which indeed is but a ceſſation according to the uſual courſe of nature.

14. We put a piece of ſhining fiſh into a wide-mouthed glaſs, about half filled with fair water, and having placed this glaſs in a receiver, we exhauſted the air for a good while; to obſerve, when the preſſure of the air was removed, and yet (by reaſon of the water that before kept the air from immediately touching the fiſh) the exhauſtion of the receiver did not deprive the fiſh of that contact of air, which it had loſt before; whether, in this caſe the abſence of the air would have the ſame influence on the ſhining body, as in the former experiments.

And here, as far as the numerous bubbles excited in the water would give us leave to diſcern it, we could not perceive, that either the abſence or return of the air, had any great operation upon the light of the immerſed body.

I ſhall further add, that though, when I formerly put together ſome notes about luminous bodies, I confined not my obſervations to one or two ſorts of fiſhes, yet theſe experiments were all of them (except a collateral one or two) made with whitings; which, among the fiſhes, I have had occaſion to take notice of, are (except one ſort that I cannot procure) the fitteſt for ſuch trials.

15. To proſecute the *1ſt* and *9th* experiments in one trial, we took, ſomewhat late at night, a piece of rotten fiſh, which we judged to ſhine too ſtrongly to be quickly deprived of all its light; and having put it into a ſmall and clear receiver, we found, that the light was much impaired, but nothing near ſuppreſſed by withdrawing the air. Whereſore, having removed the receiver into a convenient place, I cauſed it to be brought to me about midnight; and having made the place pretty dark, I perceived the included body to continue to ſhine more vividly than one would have expected; and, if I miſtake not, I ſaw it ſhining in the morning whilſt it was dark; but the night after, coming to look upon it again, its light appeared no more. Notwithſtanding which, I made a ſhift to keep out the air about 24 hours longer; and ſo, after 48 hours in all, we opened the receiver in a dark place; and preſently, upon the ingreſs of the air, were pleaſingly ſaluted with ſo vivid an apparition of light, that the included body continued to ſhine, when carried into a room, where there burnt both fire and candle, if it were, but by a hat, ſcreen'd from the beams.

Being encouraged, as well as pleaſed with this ſucceſs, we forthwith exhauſted the air once more out of the ſame receiver; and having kept it about four hours longer, we looked upon it again in a dark place; and finding no appearance of light, let the air in upon it, whereby it was made to ſhine again, and that vigorouſly enough.

The ſuddenneſs, with which the included body appeared to be, as 'twere, re-kindled upon the firſt contact of the air, revived in me ſome ſuſpicions I have had, about the poſſible cauſes of thoſe ſhort-liv'd apparitions of light (I ſpeak not now of real lamps found in tombs) which diſcloſing themſelves upon mens coming in, and conſequently letting freſh air into the vaults, that had been very long kept cloſe, did ſoon after vaniſh.

Theſe thoughts, as I was ſaying, occurred to me upon what I have been relating, by reaſon of the ſudden operation of the freſh air, on a body, that but a minute before diſcloſed no light. For though the lights reported to have been ſeen in caves, quickly diſappeared, which that of our fiſh did not; yet that difference might poſſibly proceed from the tenacity, or ſome other diſpoſition of the matter, wherein the luminouſneſs of the fiſh reſides: for I remember, that I have more than once obſerved a certain glimmering, and ſmall ſparks of light to be produced in a ſort of bodies, upon putting them out of their former reſt, and taking them into the air; which ſparks would vaniſh of themſelves, ſometimes within one minute, and ſometimes within a few minutes. But as theſe thoughts were only tranſient conjectures, ſo I ſhall not inſiſt any longer upon them; but rather contenting my ſelf with the hint already given, take notice of what may be more certainly deduced from our experiment; which is, that the air may have a much greater intereſt in many odd phenomena of nature, than we are hitherto aware of.

And, for confirmation of our experiment, I ſhall add, that having, in another receiver, eclipſed a piece of fiſh, that ſhone when 'twas put in more languidly than ſeveral others that we had tried, I kept it about three days and three nights in a receiver; after which, I opened it in the dark, and upon letting in the air upon this body, that ſhone but faintly at firſt, it immediately recovered its ſo long ſuppreſſed light. And having included another piece that was yet more faint than that, when put into the receiver, and having kept this piece alſo three days and three nights in the exhauſted glaſs, I let in the air upon it; and notwithſtanding the darkneſs of the place, nothing of light was thereupon revived. But this being little other than I expected, from a body that ſhone ſo faintly, when 'twas put into the receiver, and had been kept there ſo long; I reſolved to try, whether the appulſe and contact of the air, would have that operation after ſome time, that it had not at firſt; and accordingly, after having waited a while, I obſerved the fiſh to diſcloſe a light, which, though but dim, was yet manifeſt enough.

I ſhall only add, that having included in ſmall receivers two pieces of rotten whitings, whereof the one, before it was put in, ſcarce ſhone ſo vividly as did the other after the receiver was exhauſted; and having ordered the matter ſo, that we were able to keep out the air for ſome days; at the end of about forty eight hours, we found, that the more ſtrongly ſhining body retained yet a deal of light; but afterwards looking upon them both in a dark place, we could not perceive in either any ſhow of light. Wherefore having let the air into that receiver, wherein the body, that at firſt ſhone the fainteſt, had been put, there did not enſue any glimmering of light for a pretty while: nay, upon the ruſhing of the air into the other glaſs, the body that at firſt ſhone ſo ſtrongly, and that continued to ſhine ſo long, ſhewed no glimmering of light. But within leſs than the quarter of an hour, we ſaw a manifeſt light in the body laſt named, and a while after, the other alſo became viſible, but by a very dim light. The more luminous of theſe bodies I obſerved to retain ſome light twenty four hours after; and the experiment had this peculiar inſtance in it, that the two receivers were uninterruptedly kept exhauſted no leſs than four days, and as many nights.

The light of rotten wood compared with that of a glowing coal.

The things, wherein I obſerved a piece of ſhining wood and a burning coal to agree or reſemble each other, are principally theſe five.

1. Both of them are luminaries, that is, give light, as having it (if I may ſo ſpeak) reſiding in them; and not like looking-glaſſes or white bodies, which are conſpicuous only by the incident beams of the ſun, or ſome other luminous body, which they reflect.

This is evident, becauſe both ſhining wood and a burning coal, ſhine the more vividly, as the place wherein they are put is made the darker, by the careful excluſion of the adventitious light.

2. Both ſhining wood and a burning coal need the preſence of the air, (and that too of a certain denſity,) to make them continue ſhining.

This has been prov'd as to a coal, by what I publiſhed in my *Phyſico-Mechanical Experiments*: and as to the ſhining wood, the experiments lately recited, make it needleſs for me to add any other proof of the requiſiteneſs, not only of air, but of air of ſuch a thickneſs, to make its light continue.

3. Both ſhining wood and a burning coal, having been deprived, for a time, of their light, by the withdrawing of the contiguous air, may preſently recover it, by letting in freſh air upon them.

Particular tryals have often ſhewn the former part of this propoſition to be true, as when kindled coals, that ſeem to be extinguiſht in our exhauſted receivers, are preſently revived, the air being reſtored to them: and the latter part is abundantly manifeſt by the experiments above mentioned.

4. Both a quick coal and ſhining wood will be eaſily quenched by water, and many other liquors.

The truth of this, as to coals, is too obvious to need a proof, and therefore I ſhall confirm it only as to wood; for which purpoſe, take the following tranſcript of ſome of my notes about light.

I took a piece of ſhining wood, and having wetted it with a little common water in a clear glaſs, it preſently loſt all its light.

The like experiment I tried with ſtrong ſpirit of ſalt, and alſo with a weak ſpirit of ſal-armoniac; but in both, the light did upon the wood's imbibing the liquor, preſently diſappear.

I made the like tryal with rectified oil of turpentine, with like ſucceſs. The ſame experiment I tried more than once with high rectified ſpirit of wine, which immediately deſtroy'd all the light of the wood that was immerſed in it; and having put a little of that liquor with my finger upon a part of the whole piece of wood that ſhone very vigorouſly, it quickly, as it were, quench'd the coal as far as the liquor reached; nor did it in a pretty while, if at all, regain its luminouſneſs.

5. As a quick-coal is not to be extinguiſh'd by the coldneſs of the air, when that is greater than ordinary; ſo neither is a piece of ſhining wood to be deprived of its light by the ſame quality of the air.

As much of this obſervation as concerns the coal, will be readily granted; and for proof of the other part of it, the following trial may ſuffice.

I took a ſmall piece of ſhining wood, and put it into a ſlender glaſs-pipe, ſealed at one end, but open at the other, and placed this pipe in a glaſs-veſſel, where I cauſed to be put a ſtrongly frigorific mixture of ice and ſalt; but having kept it there full as long as would be requiſite to freeze an aqueous body, I afterwards took it out, and perceived not any ſenſible diminution of its light. But tho' the light of ſhining fiſh be uſually (as far as I have obſerved) more vigorous and durable than that of ſhining wood; yet I cannot ſay, that it will hold out againſt cold ſo well as the other: for having ordered one of my ſervants to cut off a good large piece of a luminous whiting, and bury it in ice and ſalt; when I called for it in leſs than half an hour after, I found it much ſtiffened by the cold, and to have no light, that I could diſcern in a dark place. And for fear that this effect might have proceeded not barely from the operation of the cold, but alſo from that of the ſalt, I cauſed at another time, a piece of whiting to be put in a pipe of glaſs, ſealed at one end, and having ſeen it ſhine there, I looked upon it again, after it had ſtayed but a quarter of an hour, by my eſtimate, in a frigorific mixture, which the glaſs kept from touching the fiſh; and yet I could not perceive, in a dark place, that it retained any light.

1. The firſt difference I obſerved betwixt a live coal and ſhing wood is, that whereas the light of the former is readily extinguiſhable by compreſſion (as is obvious in the practice of ſuddenly extinguiſhing a

piece of coal by treading upon it) I could not find that ſuch a compreſſion as I could conveniently give without loſing ſight of its operation, would put out, or much injure the light, even of ſmall fragments of ſhining wood. One of my tryals about this I find thus ſet down.

I took a piece of ſhining wood, and having preſſed it between two pieces of clear glaſs (whereof the one was pretty flat, and the other convex) ſo that I could clearly ſee the wood through the glaſs, I could not perceive, that the compreſſion, tho' it ſometimes broke the wood into ſeveral fragments, did either deſtroy, or conſiderably alter the light.

2. The next difference to be taken notice of betwixt rotten wood and a kindled coal is, that the latter will, in a very few minutes, be totally extinguiſh'd by withdrawing the air; whereas a piece of ſhining wood, being eclipſed by the abſence of the air, and kept ſo for a time, will immediately recover its light, if the air be let in upon it again within half an hour after it was firſt withdrawn.

The former part of this obſervation is eaſily proved by the experiments that have been often made upon quick coals in the pneumatical engine; and the truth of the latter part appears by the experiments about ſhining wood, mentioned above. Neither is it improbable, that, if I had conveniency to try it, I ſhou'd have found that a piece of ſhining wood, deprived of its light by the removal of the ambient air, would retain a diſpoſition to recover it upon the return of the air, not only for half an hour, but for half a day, and perhaps a longer time.

3. The next difference to be mentioned is, that a live coal being put into a ſmall cloſe glaſs, will not continue to burn for very many minutes; but a piece of ſhining wood will continue to ſhine for ſome whole days.

The firſt part of the aſſertion, I know will be readily granted; and the other part of it may be eaſily made out by what I have tried upon ſhining wood, ſealed up hermetically in very ſmall glaſſes, where the wood did, for ſeveral days, retain its light.

4. A fourth difference may be this: that whereas a coal, as it burns, ſends forth ſtore of ſmoak or exhalations; luminous wood does not.

5. A fifth, flowing from the former is, that whereas a coal in ſhining waſts it ſelf at a great rate, ſhining wood does not.

Theſe two differences I mention together; becauſe what concerns the coal in both, will need no proof; and as for what concerns rotten wood, it may be verified by an obſervation, that I made in a piece of it hermetically ſealed up in a ſmall clear glaſs; where, after it had continued luminous for ſome days, I looked on it in the day-time, to perceive, if any ſtore of ſpirits, or other ſteams, had, during all that while, exhaled from the wood; but could not find any on the inſide of the glaſs, except that in one place there appeared a kind of dew, conſiſting of ſuch very ſmall drops, that a multitude of them would go to the making up one ordinary drop. But in pieces of ſhining fiſh, I found the caſe much otherwiſe, as was to be expected.

6. The laſt difference I ſhall take notice of betwixt the bodies hitherto compared, is, that tho' a quick coal be actually and vehemently hot; I have not obſerved ſhining wood to be ſo much as ſenſibly lukewarm.

What is ſaid of the coal's heat, being as manifeſt as its light, I ſhall need only to make out what relates to the ſhining wood. To aſſiſt me wherein, I meet, among my notes, the following experiment.

I put upon a large piece of wood, which was partly ſhining, and, as near as I could, upon one of the moſt luminous parts of it, one of thoſe thermometers, that I make with a pendulous drop of water. But as I had formerly tried, that by laying the tip of my noſe, or finger, upon it, when it ſhone vividly enough, to enable me to diſcern both the one and the other at the time of contact, I could not perceive the leaſt of heat, but rather an actual coldneſs; ſo by this trial I could not ſatisfie my ſelf, that it did viſibly raiſe the pendulous drop, tho' the inſtrument were ſo tender, that by approaching one finger near it, yet without actually touching it, 'twould manifeſtly be impelled up; and upon the removal of my finger, preſently deſcend again.

And I remember, having put ſuch an inſtrument upon a ſhining fiſh, that was pretty large, I could not thereby perceive, it had any degree of heat, but rather the contrary: and having ſeveral times taken off the glaſs, to apply it with the more advantage to ſeveral parts of the luminous fiſh, I often took notice, that upon the removal of the glaſs into the air, the pendulous drop would manifeſtly riſe a little, and ſubſide again when the glaſs was applied to the fiſh. But whether this part of the experiment will hold in all temperatures of the air, I had not opportunity to try.

Obſervations upon ſhining fleſh.

1. *Febr.* 15. 167$\frac{1}{2}$. When I was about to go to bed, an amanuenſis of mine informed me, that one of the ſervants of the houſe, going, upon ſome occaſion, into the larder, was frighted by ſomething of luminous that, notwithſtanding the darkneſs of the place, ſhe ſaw, where meat had been hung up before. Upon this I preſently ſent for the meat into my chamber, and cauſed it to be placed in a corner of the room, made conſiderably dark; and then plainly ſaw, with wonder and delight, that the joint of meat did, in divers places, ſhine like rotten wood or putrid fiſh. The chief circumſtances and phenomena, that I had opportunity to take notice of, at ſo inconvenient an hour, were theſe.

1. But firſt I muſt obſerve, that the ſubject, I ſpeak of, was a neck of veal, which had been bought of a country-butcher on the *Tueſday* preceeding.

2. In this one piece of meat I reckon'd diſtinctly above twenty ſeveral places that ſhone, tho' not all of them alike; ſome of them doing it but very faintly.

3. The ſize of theſe lucid parts was different; ſome of them being as big as the nail of a man's middle finger, ſome few bigger, but moſt of them leſs. Nor were their figures at all more uniform; ſome being inclined to round, others almoſt oval, but the greateſt part of them very irregularly ſhap'd.

4. The places that ſhone moſt, were ſome griſtly or ſoft parts of the bones, where the butcher's cleaver had paſſed: but theſe were not the only luminous parts; for by drawing to and fro the *Medulla ſpinalis*, we found that a part of that alſo ſhone not ill. And I perceived one place in a tendon, to afford ſome light; and, laſtly, three or four ſpots in the fleſhy parts, at a large diſtance from the bones, were plainly diſcovered by their own light, tho' that were fainter than in the parts above-mentioned.

5. When all theſe lucid parts were ſurveyed together, they made a very ſplendid ſhew: ſo that applying a printed paper to ſome of the more reſplendent ſpots, I could plainly read ſeveral ſucceeding letters of the title.

6. The colour that accompanied the light was not in all the ſame: but in thoſe which ſhone livelieſt, it ſeemed to have ſuch a fine greeniſh blue, as I have often obſerved in the tails of glow-worms.

7. But notwithſtanding the vividneſs of this light, I could not, by the touch, diſcern the leaſt degree of heat in the parts whence it proceeded; and having put ſome marks on one or two of the more ſhining places, that I might know them again when brought to the light, I for a pretty while apply'd to them a ſealed weather-glaſs, furniſhed with tinged ſpirit of wine, but could not ſatisfie my ſelf, that the ſhining parts did at all ſenſibly warm the liquor.

8. Notwithſtanding the great number of lucid parts in this neck of veal, yet neither I, nor any of thoſe who were about me, could perceive the leaſt ill ſcent, whence to infer any putrefaction; the meat being judged very freſh, well conditioned, and fit for dreſſing.

9. The floor of the larder, where this meat was kept, is almoſt a ſtory lower than the level of the ſtreet, being divided from the kitchin but by a partition of boards, and furniſhed but with one window, which is not great, and looks towards the ſtreet, that lies northward from it.

10. The wind, as far as we could obſerve it, was then at ſouth-weſt, and bluſtering. The air, by the ſeal'd thermometer, appeared hot for the ſeaſon. The moon was paſt its laſt quarter. The mercury in the barometer ſtood at $29\frac{3}{16}$ inches.

11. We cut off, with a knife, one of the luminous parts, which proved to be a tender bone, about the thickneſs of a half-crown piece, and this appeared to ſhine on both ſides, tho' not equally; and that part of the bone, whence it had been cut, continued joined

to the reſt of the neck of veal, and was ſeen to ſhine; but nothing near ſo vividly as the part we had taken off did before.

12. To try, whether I could obtain any juice, or moiſt ſubſtance, from this, as I have ſeveral times done from the tails of glow-worms, I rub'd ſome of the ſofter and more lucid parts, as dextrouſly as I could, upon my hand, but did not at all perceive any luminous moiſture was thereby imparted; though the fleſh ſeemed by that operation to have loſt ſome of its light.

13. I cauſed alſo a piece of ſhining fleſh to be compreſſed betwixt two pieces of glaſs; but I did not find the light to be thereby extinguiſhed.

14. I put a luminous piece of the veal into a cryſtalline vial; and pouring on it a little pure ſpirit of wine, after I had ſhaken them together, I laid by the glaſs, and in about a quarter of an hour, or leſs, I found that the light was vaniſhed.

15. But water would not ſo eaſily quench our ſeeming fires; for having put one of them into a *China* cup, and almoſt filled it with cold water, the light did not only appear, perhaps undiminiſhed, through that liquor, but above an hour after was vigorous enough not to be eclipſed, though looked upon at no great diſtance from a burning candle.

16. While theſe things were doing, I cauſed the pneumatical engine to be prepared in a room without fire, (that the experiment might be tried in a greater degree of darkneſs;) and having conveyed one of the largeſt luminous pieces into a ſmall receiver, we cauſed the pump to be plied in the dark; and perceived, upon the gradual withdrawing of the air, a gradual leſſening of the light; which yet was never brought quite to diſappear, (as the light of rotten wood and glow-worms wou'd have done) or to be ſo near vaniſhing as one would have expected. But by the haſty increaſe of light, that diſcloſed it ſelf in the veal, upon letting in of the air to the exhauſted receiver, it appeared more manifeſtly than before, that the decreaſe, though but ſlowly made, had been conſiderable. This trial we once more repeated, with like ſucceſs; which, though it convinced us, that the luminous matter of our included body, was more vigorous, or tenacious, than that of moſt other ſhining bodies; yet it left us ſome doubt, that the light would have been much more impaired, if not quite made to vaniſh, if the ſubject of it could have been kept long enough in our exhauſted receiver.

17. It was alſo found, that a leg of the ſame veal, had ſome ſhining places in it; though they were but very few and faint in compariſon of thoſe conſpicuous in the above-mentioned neck.

18. *March* 16. Between four and five in the morning, I looked upon a clean vial, that I had laid upon the bed by me, after a piece of our luminous veal was included in it, and found it to ſhine vividly. I looked upon it again the third day, incluſively, after we had

firſt obſerved the meat 'twas cut off from to be luminous, and I found it to ſhine in the dark as vigorouſly as ever: on the 4*th* day, its light was alſo conſpicuous; ſo that I was able, in a dark corner of the room, to ſhew it even in the day time to three or four very ingenious phyſicians. But before the night following, the light began to decay, and the offenſive ſmell to grow ſomewhat ſtrong; which ſeems to argue, that the diſpoſition, upon whoſe account our veal was luminous, may very well conſiſt, both with its being, and not being in a ſtate of putrefaction, and conſequently is not likely to be derived merely from the one or the other. The 5*th* day, in the morning, looking upon it before the curtains were opened, it ſeemed to ſhine better than it had done the day preceding. The ſame night alſo it was manifeſt enough, though not vivid, in the dark. When I awaked, the 6*th* day in the morning, after the ſun was riſen, I could within the curtains perceive a glimmering light; but the 7*th* day, I could not, late at night, diſcern any light at all.

19. I ſhall only add one obſervation more, which may poſſibly take our thoughts from attempting to deduce the ſhining of our veal from the peculiar nouriſhment, conſtitution, or properties of that individual calf, whoſe fleſh it was. For, having ſeveral nights ſent purpoſely into the larder, to obſerve, whether any veal, ſince brought thither, or any other meat, did afford any light; a negative anſwer was always brought me; except at one time, which happened to be within leſs than 48 hours of that wherein the luminouſneſs of the veal had been firſt taken notice of; for at this time there was in the ſame larder, a conſpicuous light ſeen in a pullet, that hung up there; which having cauſed to be brought up in a darkened part of my chamber in the night time, I perceived four or five luminous places, that were not indeed near ſo large as thoſe of the veal, but were little leſs vivid than they. All of theſe, I took notice, were either upon or near the rump; and that which appeared moſt like a ſpark of fire, ſhone at the very top of that part. Yet was not this fowl putrefied, nor at all ill-ſcented, but ſo freſh, that the next day I found it very good meat. And thus much for natural * *Phoſphori*:

phori :

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* The mercurial phoſphorus is a late diſcovery; and has been laboriouſly treated of by M. *Bernoulli*, who ſeems to claim the honour, if not of the invention, yet of having reduced the phenomena to rules, and ſettled the doctrine thereof. The late Mr. *Hauksbee*, alſo, has made many experiments relating to this matter; whence it appears, that light is producible from quick-ſilver, by paſſing common air thro' the body of it, after the glaſs receiver is well exhauſted; that a peculiar figure, and motion of parts, and a proper medium for thoſe motions to be perform'd in, are requiſite to the production of this light; that a much leſs rarified medium than a vacuum, is ſufficient for the exhibition of this phenomena; and that light is producible by the agitation of mercury in the open air, tho' this be very different from that produced *in vacuo*, or a highly rarified medium; the luminous parts in the former caſe being diſtinct and ſeparate, but united into a continued body in the other. But per-

haps,

NAT. HIST. *phori*: we ſhall next proceed to conſider the artificial kind.

haps, the phenomenon is, in ſome degree, owing to the friction of the glaſs; for this being briſkly rubbed with a dry body, will afford a light in a dark place. See *Hauksbee*'s *Phyſico Mechan. Experiments*, p. 6—20, and p. 45—52.

It appears alſo from other experiments of the ſame curious perſon, that light accompanied with heat, is producible *in vacuo*, by the friction of amber upon woollen. And M. *Bernoulli* informs us, that the attrition of a diamond may produce a light as vivid and ſtrong, as that of a glowing coal briſkly agitated with bellows.

"Do not, ſays Sir *Iſ. Newton*, all fixed bodies, when heated beyond a certain degree, emit light and ſhine; and is not this emiſſion performed by the vibrating motion of their parts? And do not all bodies which abound in terreſtrial parts, and eſpecially in ſulphureous ones, emit light as often as thoſe parts are ſufficiently agitated; whether that agitation be made by heat, or by friction, or percuſſion, or putrefaction, or by any violent motion, or any other cauſe? As for inſtance, ſea-water in a raging ſtorm; quick-ſilver agitated *in vacuo*; the back of a cat, or the neck of a horſe, obliquely ſtruck, or rubbed in a dark place; wood, fleſh, and fiſh, while they putrefie; vapours ariſing from putrefied waters, uſually call'd *Ignes fatui*; ſtacks of moiſt hay, or corn growing hot by fermentation; glow-worms, or the eyes of ſome animals by vital motions; the vulgar phoſphorus agitated by the attrition of any body, or by the acid particles of the air; amber, and ſome diamonds, by ſtriking, preſſing, or rubbing them; ſcrapings of ſteel ſtruck off with a flint; iron hammer'd very nimbly, till it become ſo hot, as to kindle ſulphur thrown upon it; the axle-trees of chariots taking fire by the rapid rotation of the wheels; and ſome liquors mixed with one another, whoſe particles come together with an impetus. So alſo a globe of glaſs, about 8 or 10 inches in diameter, being put into a frame, where it may be ſwiftly turn'd round its axis, will, in turning, ſhine where it rubs againſt the palm of one's hand apply'd to it: and if, at the ſame time, a piece of white paper, or white cloth, or the end of one's finger, be held at the diſtance of about a quarter, or half an inch, from that part of the glaſs where it is moſt in motion; the electric vapour, which is excited by the friction of the glaſs againſt the hand, will, by daſhing againſt the paper, cloth, or finger, be put into ſuch an agitation, as to emit light, and make the paper, cloth, or finger, appear lucid like a glow-worm; and in ruſhing out of the glaſs, will ſometimes puſh againſt the finger, ſo as to be felt. And the ſame things have been found, by rubbing a long and large cylinder of glaſs, or amber, with a paper held in one's hand, and continuing the friction till the glaſs grew warm." *Newton. Optic.* p. 314—316.

THE AERIAL NOCTILUCA.

SECT. I.

The ſeveral kinds of artificial phoſphori.

I Here propoſe to ſpeak only of the artificial phoſphori *. And, as far as I have hitherto obſerv'd, thoſe factitious ſhining bodies, that paſs under the name of phoſphori, may be reduced to two principal kinds; one of which may be ſubdivided into two or three. The firſt of theſe conſiſts of ſuch bodies, as ſhine, for ſome time, in the dark, only after being expos'd to the rays of the ſun, or of a vigorous flame; of this kind is the *Bolonian* ſtone, skilfully prepared, and the *Phoſphorus hermeticus* of *Balduinus*; which proved therefore very welcome to the curious, becauſe the *Bolonian* ſtone was for ſome years before grown exceeding ſcarce, even in *Italy*. And this, an ingenious traveller, then lately come out of thoſe parts, imputed to the death of the perſon who uſed to prepare the ſtone, at *Bolognia*; without having left a ſufficient account of his way of making it lucid. And the phoſphorus of *Balduinus*, which, or the like, may be made both of chalk, and another ſubſtance, ſeem'd to me, when the preparation ſucceeded beſt, to catch the external light far more readily than the *Bolonian* ſtone. For I have had of it, that, when freſh made, wou'd, within about half a minute, be manifeſtly excited, and as it were kindled; ſo that being preſently removed into a dark place, it wou'd retain a very ſenſible light, tho' the external luminary whereto it had been expoſed, were but the flame of a candle.

But as theſe phoſphori cou'd very hardly be preſerv'd for any long time, ſo ſome of them in a few months, and others in a few weeks, wou'd appear crack'd, and loſe their faculty of being excited by the beams of light; whilſt the *Bolonian* ſtone, skilfully prepared, wou'd retain this faculty much longer. For I had a ſmall piece of it, which, tho' kept negligently, in an ordinary wooden box, preſerv'd its virtue for ſeveral years.

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* "Phoſphori in general, ſays M. *Lemery*, may be looked upon as a kind of "ſponges, full of luminous matter, which "they contain ſo looſely, that a ſmall "external force will ſtrike it out, and "give it a luminous form." *French Memoir.* A. 1709. p. 542.

But beſides this firſt kind of phoſphorus, which, to be able to ſhine, muſt have its faculty excited by the beams of the ſun, or of ſome other actually ſhining body; there is another ſort which needs no ſuch aſſiſtance, yet continues to ſhine far longer than the *Bolonian* ſtone, or the phoſphorus of *Balduinus*. This by ſome has been called a noctiluca, but more properly a ſelf-ſhining or luminous ſubſtance; and of this Mr. *Krafft*, a *German* chymiſt, ſhew'd his majeſty two ſorts or degrees. To the firſt whereof, I gave the name of conſiſtent, or gummous noctiluca; this ſubſtance being at leaſt as yielding as bees-wax in ſummer, and its texture not very unlike that of cherry-tree gum. And on account of its uninterrupted action, 'tis term'd by ſome in *Germany*, the conſtant noctiluca, which title it deſerves; ſince this phoſphorus is by far the nobleſt we have yet ſeen. For tho' there were not much of it, and tho' kept by it ſelf, in a little vial well ſtopped, it would, without being externally excited, inceſſantly ſhine, as he affirmed, both day and night; yet the light it afforded, ſeemed but little, if at all more vivid than I have ſometimes obſerved in the liquor of glow-worms, and other natural phoſphori.

Beſides this gummous noctiluca, Mr. *Krafft* had a liquid one, that, perhaps, was made only by diſſolving the former in ſome convenient liquor, tho' the lucidneſs of this was not permanent like that of the other; but within no very long time, eſpecially when 'twas divided into ſmaller portions, and left expoſed to the air, wou'd expire or vaniſh.

And beſides the gummous, and the liquid noctiluca, hitherto mentioned, we may add a third kind that we our ſelves lately prepared, which ſeems to be of a ſomewhat different nature from them both; for ours wou'd not ſhine of it ſelf, like the conſtant noctiluca, nor yet after the manner of the liquid noctiluca; but the bare contact of the air, without any external rays or heat, would therein, immediately produce a light, that might eaſily be made durable in a well-ſtopped veſſel; and, which is conſiderable, the ſhining ſubſtance was not the body of the liquor included in the vial, but an exhalation or effluvium, mix'd with the admitted air; for both which reaſons I gave it the name of the aerial noctiluca.

Theſe are the ſeveral phoſphori that I have yet ſeen; but future induſtry may diſcover ſome new kinds or variations of ſelf-ſhining ſubſtances, which will deſerve new names; and among them, perhaps, that of ſolid noctiluca's.

The origin of the aerial noctiluca.

After Mr. *Krafft* had ſhewn me both his liquid and conſiſtent phoſphorus; being, by the phenomena I then obſerved, made certain, that there is really ſuch a factitious body to be made, as wou'd ſhine in the dark, without having been before illumined by any lucid ſubſtance, and without being hot as to ſenſe; I conſidered in what way it might be moſt probable to produce, by art, ſuch a ſhining ſubſtance. Mr. *Krafft*, indeed, gave me in return of a ſecret I communicated to him, a re-a remote hint of the principal matter of his phoſphori, by ſaying it was ſomewhat that belong'd to the body of man.

But I made many fruitleſs attempts, with many unlucky accidents, before I cou'd bring the thing to bear; till, at length, being confident upon the nature of the thing, I would not believe the ſkilful labourer when he told me, with concern, that what I expected was not produced; but going my ſelf to the laboratory, I quickly found, that by the help of the air, or ſome agitation of what had paſs'd into the receiver, I cou'd, in a dark place, tho' it was then day, perceive ſome glimmerings of light.

But this tedious purſuit only gave me a liquid phoſphorus, not ſuch a ſolid one as that of Mr. *Krafft*; and I was willing to think, that this defect might be imputed to the cracking of the retort, before the operation was quite finiſhed. However, I have, by this means, found a ſubſtance that needs nothing but the air to kindle it, and that in a moment.*

The uſes of phoſphori.

The uſes that may be made of a noctiluca, eſpecially of the conſiſtent kind, are not, in probability, to be all of them eaſily foreſeen. But if the lucid virtue of the conſtant noctiluca cou'd be conſiderably invigorated, it might prevent a great deal of danger to which ſhips are expoſed, by the neceſſity men often have to come into the gun-room, with common flames, to take out powder. And, perhaps, our light may be of uſe to thoſe who dive in deep waters; and might very ſafely and conveniently be let down into the ſea, to what depth one pleaſes, and kept there for a long time, to draw together the fiſh, that will reſort to the light of a fire or candle; as is practiſed in ſeveral parts of *Scotland* and *Ireland*, by the fiſhermen †. The ſelf-ſhining ſubſtance, which is our aerial noctiluca, affords a light, that was able, when I wak'd in the night, to ſhew me diſtinctly the bigneſs and ſhape of ſome joints of my fingers, and diſcover'd it ſelf in the form of a capital letter, cut out of a piece of black paper, paſted upon the vial; ſo that it may, probably, ſuffice to ſhew the hour of the night, when one wakes, if it be placed, inſtead of a lamp or candle, behind an index, where the figures employed to mark the hours, are cut out. It may alſo ſerve to make a guide knowable at a diſtance, in tempeſtuous winds, great ſhowers, and the darkeſt nights. Probably, alſo, ſo ſubtile and noble a ſubſtance may have great medicinal virtues. And tho' our noctiluca had none of theſe, yet it may be highly valuable, if it ſhall be found conducive to diſcover the nature of light.

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* From Mr. *Hauksbee*'s experiments, made with the phoſphorus of urine, it appears, that its light is improved, or made more diſtinct, by the rarifaction of the air; or the taking off the preſſure of the atmoſphere. See *Hauksbee*'s *Experim*: p. 122—124.

† For theſe and the like purpoſes M. *Bernoulli*'s perpetual, portable phoſphorus ſeems much better contrived. This phoſphorus is only a proper quantity of well purified mercury, incloſed in a very clean glaſs veſſel, thoroughly exhauſted of air; for ſuch a veſſel being barely ſhook, will afford a very conſiderable light in the dark, without the leaſt danger of fire.

But to come to what I here chiefly intend, the obſervations we made upon our noctiluca.

Obſervations made upon the aerial noctiluca.

1. The veſſels not holding entire to the laſt, we had more difficulty than we expected, to get out the ſhining matter; and were obliged to ſave as much as we cou'd of it, by ſmall parcels, in diſtinct vials, whereof, tho' the firſt was judged to contain the moſt vigorous portion of the ſhining liquor, yet I thought fit to make my trials with the noctiluca, ſaved in the ſecond; ſetting aſide ſome more faint and aqueous liquor, that we afterwards ſaved in a third vial; with a a thicker matter that remained upon a paper, when ſome of the liquor had been put into it to be filter'd; and this paper we kept in a fourth glaſs, which, tho' wide-mouthed, was carefully ſtopp'd.

2. The ſecond vial was capable of holding about two ounces of water; but it contained not above one ſpoonful of our ſhining liquor; which by day-light appeared muddy, and of a greyiſh colour; ſomewhat like common water render'd opake, by a quantity of wood-aſhes well mixed with it. When no light appeared in the glaſs, we obſerv'd all the cavity that reached from the liquor to the neck, to be tranſparent; as if there were nothing but a ſpoonful of dirty water at the bottom of it. But when the liquor was made to ſhine vividly, all the cavity of the glaſs unpoſſeſs'd by the liquor appeared, in an external light, to be full of fumes; which, being, in the containing vial, removed into a dark place, appeared lucid; and ſometimes like a flame that ſeemed to be reverberated; and to be made, as it were, to circulate by the cloſe ſtopp'd neck, and the ſides of the vial. And the appearance of whitiſh fumes, when the glaſs was look'd upon in an external light, was ſo uſual a concomitant of its fitneſs to ſhine in the dark, that upon viewing the vial by day-light, I cou'd readily tell, by the preſence or abſence of that miſt, whether the matter wou'd, in a dark place, appear luminous or not?

3 When this liquor had been kept for an hour or two, in ſome dark, quiet place, or even in the pocket; if in a darkned room, my eyes were caſt toward the place where the vial was held, I cou'd not perceive it to afford any light at all; and tho' the liquor were ſtrongly ſhook, yet I cou'd not diſcern, that this motion alone was able to bring it, or its vapours, to be manifeſtly lucid. But as ſoon as I unſtopp'd the vial in the dark, there began to appear a light, or flame, in the cavity of it. Whatever be the nature and ſubject of this light, it appeared to have a great dependance on the freſh air: for, (1.) I never obſerved it, either in the liquor, or upon the ſurface thereof; but ſtill the ſhining began at the upper part, which was firſt touched by the outward air, and made a progreſs quick indeed, tho' not ſo inſtantaneous, but the eye cou'd follow it from the top to the bottom of the vial.

(2.) The contact of the air ſeemed neceſſary to the propagation, as well as the production of this flame or light; for if having ſhaken the vial, that the liquor might either wet the ſtopple, or communicate ſomething to it, I warily bent the cork, ſo that only a few particles of the outward air cou'd inſinuate themſelves between the ſtopple and the neck of the glaſs; there would appear on the ſides, and, perhaps, beneath the cork, little flames, as it were; which yet, tho' very vivid, were not able to propagate themſelves downwards; but when the cork was quite removed, and acceſs thereby allowed to a greater quantity of air, the flame, or light, preſently diffuſed it ſelf thro' the whole cavity of the vial, and reached as low as the ſurface of the liquor. (3.) Tho' often the light ſeemed more vivid near the ſurface of the liquor than elſewhere, yet when by ſtopping the vial again, preſently after I had open'd it, I endeavoured to deſtroy the flame, or light; I generally obſerved, that when it was ready to vaniſh, it began to diſappear firſt at the bottom of the vial, and ſeemed to ſhrink more and more, as it were upwards, till it expired at the neck. (4.) But, on the other ſide, when I kept it unſtopp'd for two or three minutes, tho' I afterwards ſtopp'd the vial very cloſe; the air, that had more leiſure than ordinary to inſinuate it ſelf, wou'd ſo cheriſh the flame, that the light wou'd continue ſometimes for an hour or two, and once or twice it laſted no leſs than three hours. Laſtly; it ſeemed that ſome elaſtic particles of the included air, or ſome ſubſtance that concurr'd to maintain the flame, was waſted or depraved, and weaken'd by being pent up in the vial with the effluvia of the liquor; ſince when the vial had been kept ſtopp'd for a competent time, and its cavity appeared tranſparent in the outward light, if I cautiouſly took out the ſtopple, the external air ſeemed manifeſtly to ruſh in, as if the ſpringyneſs of the internal had been notably weaken'd by the operation of the flame upon the matter with which it was kept impriſoned. And altho' in the vial, moderately ſhaken, when the light was quite vaniſhed, I cou'd not make the liquor begin to ſhine; yet when by unſtopping it a little, the flame was kindled in the cavity of the glaſs; then by ſhaking it again, tho' more faintly than before, the light ſeemed to be manifeſtly increaſed.

4. If I laid a little of our liquor, when it was in its dark ſtate, upon my hand, or on the ſtopple of the vial, it wou'd often remain there, without diſcloſing any glimpſe of light; but if I rubb'd it with my finger, it wou'd ſhine more vividly than it uſed to do, at beſt, in the vial, when the neck of it was ſtopp'd; and this vivid light, whilſt I continued to rub the matter, ſeemed, from time to time, to flame and flaſh; and not only ſmelt offenſive, but viſibly ſent up a large ſmoke, as if it had been ſome common, culinary flame; and when, upon ceaſing to rub the liquor, it had ceaſed to ſhine for a pretty while; yet when I rubb'd it again, it wou'd again appear luminous. But by little and little the lucid virtue decay'd, till 'twas in vain to rub any more.

5. The light of our liquor, when excited, ſeemed, for degree, much like that obſerved in ſome ſpecies of rotten wood, tho' not the moſt vivid ſort; and when ſurrounded with bodies of a black colour, the reflection of it from them, was little or none. But very white bodies held contiguous to it, were manifeſtly illumined by it; eſpecially if the eye, having been long kept in the dark, was made more ſuſceptible of the fainter impreſſions of light; ſo that waking before break of day, and incloſing both the glaſs and my head between the bed-clothes, the light ſeemed to be very conſiderable, and illumined the compaſs of a foot or more in diameter; and, probably, wou'd have diffus'd it ſelf further, if it had not been bounded by the ſheets; whoſe whiteneſs made the reflection of the light from them appear very prettily. And, by the help of this light, I cou'd eaſily perceive my fingers, and a ring I wore; tho' I cou'd not diſtinguiſh the colours of a reddiſh diamond, and two emeralds, that were ſet in it. With regard to the light within, the included flame of our vial was opake; for both at ſome other times, and when I made the laſt obſervation, I cou'd not at all perceive my finger, when the ſhining ſubſtance was interpoſed betwixt it and my eye. But, in reference to the external light, the flame, or ſhining matter, was tranſparent; for even in a very faint light, by which, I think, I could ſcarce have read an ordinary print; if I held our luminous vial between the window and my eye, I could very plainly ſee my finger on the further ſide of the glaſs; tho' if my eye were placed between that and the light, the tranſparency would appear ſomewhat leſſen'd; becauſe the cavity ſeemed fill'd with a kind of whitiſh miſt. The like tranſparency, and whitiſh fumes, obſervable in the ſame luminous ſteams or flame, when the vial was look'd on againſt and from the light, I found, if inſtead of the day-light, I employed that of a candle.

6. Having the opportunity of a convenient place, and a fair day, I ſet the vial, about noon, in a window, opened towards the ſouth, and left it there expos'd to the ſun-beams for a conſiderable time; to try, whether they would, upon account of their agitation, or ſome imaginable affinity of nature, kindle or excite the liquor, or its effluvia. But I could not perceive that the ſun-beams had ſuch an operation; nor could I perceive any whitiſh, or miſt-like fumes, in the cavity of the glaſs; nor any light in the vial, placed in the darkeſt corner of the room.

7. Acid and alkaline ſpirits, being reckoned the moſt ſubtile and operative ſubſtances, obtainable from mixed bodies by diſtillation; I thought it worth while to try by the taſt, whether our ſhining liquor abounded with particles of either of thoſe kinds? I did not, however, find, that the liquor I put upon my tongue, was, in the leaſt, acid; nor that it was ſenſibly alkaline, as the ſalts and ſpirits afforded by hartſhorn, blood, *&c.* but it ſeemed to have an odd, empyreumatical taſt, almoſt like the ſpirit of crude tartar; its ſmell reſembling

that of ſome empyreumatical oil, with a ſcent ſomewhat like ſtale urine. I likewiſe, for further trial, put a little of our liquor to ſome drops of blue ſyrup of violets; but the mixture was not thereby turn'd green, which it wou'd have been by a quarter ſo much ſpirit of hartſhorn, of blood, or of ſome other ſpirit abounding with ſalt of an urinous nature.

8. Some other trials I made, with very ſmall quantities of our liquor; but theſe no more than the former ſhewed it to belong manifeſtly to the tribe of acids; or to that of alkalies *. Sometimes when I ſhook the vial, ſo that the whole body, even to the bottom of the liquor, was ſpread all over the inſide of the glaſs; I could obſerve, that in many places, ſeveral little grains, or corpuſcles, belonging to the opake matter, that concurr'd to compoſe the liquor, ſtuck here and there to the inſide of the vial; and that theſe being of a conſiſtent, not a fluid nature, and therefore, probably, more denſe than the thinner parts of the phoſphorus, ſhone very prettily and diſtinctly, almoſt like extremely little ſtars, or rather, radiant ſparks of fire, whoſe light was briſk enough to be diſtinctly viſible, notwithſtanding that of the flame was contiguous to them, and filled the cavity of the vial. And theſe ſhining corpuſcles uſually continued peculiarly vivid, as long as I thought fit to look on them.

9. Being deſirous to try, what water would do towards quenching our ſhining liquor, I thought fit to make the experiment, when time and many trials had much impaired its vigour. And, accordingly, having in a dark place unſtopp'd the vial, and wetted the tip of my finger with the included liquor, I could not perceive that it then gave any ſenſible light; wherefore, having briſkly rubb'd the moiſten'd finger againſt my other hand for a few moments, both the rubb'd part of my hand, and my finger, appear'd adorned, each of them, with a flame; and tho' upon dipping my finger in water, the flame was, as it were, extinguiſhed, ſince the light preſently vaniſhed; yet having taken it out again, and rubb'd it, without previouſly drying it upon the other hand, as I had done before, the light quickly appeared again.

10. Having one night opened the vial, I quickly ſtopp'd it again, and put it in my pocket till I went to ſleep; and then laying it by me in the bed; when the candles were carried out of the room, I perceived the light, whoſe duration I did not expect would exceed one hour, to continue ſtill vivid; then ſhaking the glaſs a little before I compoſed my ſelf to ſleep, I laid it by till I waked in the morning; when looking upon it again, it appeared to ſhine more vigorouſly than it had done at firſt: and from the time I open'd it, over-night, till

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* The phoſphorus of urine, when analyz'd, yields a very acid liquor, and a terreſtrial, unctuous ſubſtance; the former whereof is not at all inflammable, and the latter will ſcarce burn. See *Memoir. de l'Acad.* R. A. 1706. p. 350.

the laſt time I had occaſion to look upon it, the next morning, it had continued ſhining for 12 hours; to which, whether the extraordinary warmth obſerved that particular night, had contributed any thing, I dare not determine; but ſhall rather add, that tho' the phenomenon happen'd very rarely, yet this was not the only time I obſerved it; for once more it occurr'd to me, and then the light continued about fifteen hours, that I took notice of; how much longer it might have laſted, I was hindered from obſerving. But this circumſtance ſeem'd conſiderable, that the long duration of our unburning flame happen'd after the reſt of the trials and obſervations had been made; when by them the vigour of the ſhining matter might reaſonably be expected to have been very much impair'd.

11. But after the foregoing obſervations had been made with our ſecond vial; coming one night to open it, in order to ſhew the phenomenon to a friend, I found no light at all appear, tho' I ſhook the contained liquor, and kept the vial for a pretty while unſtopp'd; till having taken out ſome drops of the liquor, and rubb'd them upon my hand, they afforded ſo vivid a light, or flame, as ſatisfied him of the poſſibility of a true noctiluca. And ſince that time I have not found the vial to afford any light, barely upon its being unſtopp'd; ſo that either ſome bodies unskilful curioſity has, unknown to me, ſpoil'd the liquor; or elſe ſo little a quantity as I had at firſt, is by the many and various trials I made with it, diſpirited and exhauſted.

12. But as the air may concur to the ſhining of our noctiluca, by exciting a certain kind of brisk motion in the parts of it; I thought fit to try whether, tho' I had found the bare ſhaking of the vial to be ineffectual, yet an actual heat, whereby the parts muſt be more vehemently and variouſly agitated, might not enable the air to do what otherwiſe it cou'd not perform: I therefore held our vial near the fire till it grew conſiderably warm; and then by ſhaking it a little, and unſtopping it in a dark place, I perceiv'd the exhalations that poſſeſs'd its cavity to ſhine as formerly, but their light was very momentary; and tho' afterwards it ſometimes appeared, it was not vivid, nor laſted for a minute, or perhaps half ſo long; tho' it ſeem'd that when freſh air was then allow'd acceſs, its duration was thereby ſomewhat lengthen'd.

I now proceed to our other vials.

Phenomena of another parcel of the aerial noctiluca.

A ſmall portion of liquor, not much exceeding a ſpoonful, that was the firſt I ſaved, being put into a long and ſomewhat ſlender cylindrical vial of cryſtalline glaſs, afforded us the enſuing phenomena.

Soon after the muddy liquor was poured into the vial, it appeared vigorouſly luminous, and continued to ſhine for ten hours, that I took notice of.

And preſuming the ſhining matter was not ſo much the liquor it ſelf, as an aggregate of ſuch effluvia of it, as affected and excited by the air, wou'd become lucid; I thought fit to take particular notice how the air wou'd work upon the exhalations of this more vigorous liquor.

And accordingly having fully opened the vial, tho' I very ſoon after ſtopp'd it again, I obſerv'd a great commotion to be made in the cavity of the glaſs unpoſſeſs'd by the liquor; for the new lucid exhalations ſeemed to have a brisk, and almoſt circular motion along the ſides of the glaſs, and to make, as it were, a little whirlwind, that impetuouſly carried it round; and this renew'd rotation was not only manifeſt, but laſted much longer than one wou'd have expected; ſo great a commotion did the air ſeem to have produced in the effluvia, and perhaps in the neighbouring parts of the liquor it ſelf. Upon the ceaſing of this unuſual motion, the light did not ceaſe; tho' I obſerved not how long 'twould have laſted.

14. Having heedfully taken out the ſtopple of our vial, in our dark place, after it had, for a long time, ceaſed from ſhining; I obſerv'd the external air to ruſh into the cavity of the glaſs with noiſe, and ſo ſwiftly, that it did, I confeſs, ſurprize me; as if the preceeding flame, tho' not ſenſibly hot, had, after the manner of culinary flames, conſiderably weaken'd the ſpring of the included air; and ſo, diſabled it to reſiſt the whole preſſure of this external air; when, by the removal of the ſtopple, it was expoſed thereto. But ſometimes, when no ſuch eruption of the air had, in a long time, preceeded, I have obſerved rotations of lucid matter in the cavity of the vial; which therefore ſeem to proceed from ſome other cauſe; tho' this, whatever it be, produced but ſuch a rotation as was leſs general, leſs brisk, and leſs laſting.

15. Whilſt our liquor was yet freſh and vigorous, I dip'd my finger in it, and therewith moiſtened ſeveral parts of my hands, and thoſe of others; upon which we obſerved, that the places touch'd, eſpecially if they were a little rubb'd, ſhone very vividly, as if actual flames (but not of a blue colour, like that of common ſulphur, or of ſpirit of wine) were burning on them. And theſe flames were not at all uniform in their manner of burning; for they often ſeem'd to tremble much, and ſometimes, as 'twere, to blaze out with ſudden flaſhes, that were not laſting. And tho' it might ſeem ſtrange, that ſo ſmall a quantity of matter, as adhered to this or that part of the hand, ſhou'd afford ſo durable a flame; yet if that part were rubb'd againſt the ſame perſon's other hand, or the skin or linen of a by-ſtander, the part new touch'd wou'd ſhine as the other continued to do: and tho' theſe flames were remarkable for their vividneſs, yet they long continued to afford the company a very pleaſing ſpectacle. And, notwithſtanding the darkneſs of the room, it was manifeſt, that they emitted great plenty of a whitiſh ſmoak, which, or ſome other effluvia from the ſame matter, imbued the neighbouring air with a rank and offenſive ſmell. The colour of theſe ſeeming flames was not like the phoſphorus of *Balduinus*, when 'tis very well prepared, and has been expoſed to a vigorous light, red, almoſt like well kindled charcoal; but yellow, like that of the middle part of the flame of a candle. And notwithſtanding the blaze and ſmoak, that accompanied theſe flames, we could not perceive in them any ſen-

ſible heat; nor did they at all ſinge the fine linen of the ladies preſent, whereon ſome of them ſeem'd to burn; ſo that if we admit a *flamma vitalis* in the heart, this unburning and harmleſs flame may ſupply us with a far better illuſtration thereof, than the ſcorching flame of ſpirit of wine, that is ſtill commonly employ'd for an example of it.

16. When with my finger dipp'd in this liquor, I drew ſhort lines upon linen, there was left a ſhining tract upon that part over which my finger paſſed; yet having found it too thick, or too faintly lucid, to be employed like ink in an ordinary pen, I tried whether I cou'd draw lucid letters with a pencil, which, for that purpoſe, I dipp'd in our liquor; but was ſurprized to find, that the characters I drew did not at all ſhine in the dark. Suſpecting, however, that the pencil might have retained, among the hairs it conſiſted of, the more tenacious and vigorous parts of the matter it had imbibed, and left only the more aqueous and ſtrengthleſs parts upon the paper; I took the pencil in one hand, and with the other compreſſed and wreath'd a little the bruſhy part of it, to excite the matter, that, probably, was lodged there. By which means, that part of the pencil was brought to look as if it were all of a light-fire, and ſeem'd to burn like a ſmall wax-taper; but with a more blazing and pleaſant flame, which, ſometimes, ſhooting downwards, and playing about the hairs of the pencil, appear'd like the lambent flame deſcrib'd in *Virgil*. But this delightful phenomenon decay'd by degrees, till no more light was ſeen; after which, nevertheleſs, the flame would, of it ſelf, break out as if it came from the internal parts of the pencil, ſhine for a pretty while, and then ſeem quite to expire; yet ſtill it would, on a ſudden, diſcloſe it ſelf again; and when it had continued a while in a tremulous motion, die again to all appearance. And tho' this lambent flame did not, that I perceived, burn or ſinge the ſlender hairs, among which it ſeem'd to blaze; yet it always manifeſtly emitted as much ſmoak as a common burning taper of that bigneſs wou'd have done. This viciſſitude of extinction and re-appearance of light laſted till I was weary of obſerving it; and then having again, with my fingers, compreſs'd and ſtrongly twiſted the hairs of the pencil, I made them, as formerly, afford a conſiderable light, which I thought was in the action, accompanied with a very ſenſible, but momentary heat. But notwithſtanding this heat, 'twas in vain that I tried, by compreſſing the pencil firſt, and then rubbing it upon gun-powder, well dried and heated, to fire the powder. This I fail'd in doing, likewiſe, when I made the trial with circumſtances ſomewhat more likely to render it ſucceſsful. And indeed Mr. *Krafft*, when he kindled gun-powder at my lodging, was obliged to uſe his conſiſtent and conſtant noctiluca, and to have the gun-powder prepared, by being made ſo hot, that 'twas almoſt ready to take fire of it ſelf. But I muſt not omit what happened to my aſſiſtant, when the diſtillation of our lucid matter had been freſh made; for he having taken up ſome

of the thicker ſubſtance with a knife, to put it into a vial, and finding, that ſome of it, afterwards, ſtuck to the blade, he haſtily wiped it off with his apron, but was much ſurpriz'd to feel a ſmart heat enſue; and preſently looking upon that part of the apron, where it had been produc'd, perceiv'd in it two large holes, which both he and I concluded to be produc'd by burning; whence I judg'd it very probable, that the thicker and unctuous part of our lucid matter had a great diſpoſition to admit a very briſk agitation; ſince by an almoſt momentary, and not very vehement motion, it was put into an agitation, that made it capable of burning new callicoe, whereof the apron was made.

17. Having employed ſome of the water that was taken out of a receiver, after it had there been impregnated with the lucid matter; I thought fit to try, whether this water, wherein, probably, the ſaline particles of our ſubject might be more copiouſly diſſolved, or more active, would not diſcover ſomewhat of a volatile alkali. I, therefore, dropped a little of it upon ſome ſyrup of violets, laid on a piece of paper, and found it change the colour of the ſyrup from blue to green; which yet it did more faintly than the volatile alkalies, even when they are phlegmatic. This liquor likewiſe made ſome conflict with ſpirit of ſalt; by which I was induced to think, that a volatile alkali, not an acid ſalt, or ſpirit, was the predominant, if not the only ſalt contained in this liquor.

18. I took a vial, containing ſome luciferous matter, that was not apt to ſhine long at a time; and being well ſtopp'd, I kept it till the flame, or light within it, expired; then having placed the glaſs in a receiver on our pneumatic engine, we pumped out the air, and afterwards pull'd out the cork in a dark place; whereupon there preſently appeared ſome light in the cavity of the vial; but by reaſon of diſadvantageous circumſtances, we could not ſo well pump out the air, and hinder the ingreſs of new, as not to leave enough to excite a flame, that, by former experience, we found to need but an inconſiderable quantity of freſh air: we obſerved, however, that by the commotion of the air, occaſioned by the pumping, the flame would be blown up, or made to ſhine more vividly.

19. We afterwards took a pretty large piece of paper, well drenched in our luciferous matter, and thruſt it into a wide-mouthed glaſs; which being put, unſtopp'd, into a receiver, faſten'd to our pneumatic engine, and with it kept in a dark place, did there ſhine, by reaſon of the contact of the air, yet contained in the receiver. Preſently after this, the pump was work'd, and we obſerved, as formerly, that the commotion made of the air about the vial, manifeſtly increaſed the light for a while; and that the light ſeemed to be leſſen'd during the pauſes intercepted between theſe commotions, both by reaſon of the reſt, and of the abſence of the air. I likewiſe took notice, that the flame which ſeemed to paſs from one part of the wrinkled paper

to the other, ſometimes appeared to have, as it were, a palpitation; and to afford a very unequal light: and tho' when the external air was let in thro' the pump into the exhauſted receiver, the flame ſeemed to be quenched; yet I judge that to be only a temporary effect of the wateriſh vapours, that the air had carried along with it, in its way thro' the pump. I therefore cauſed the receiver to be taken off the engine; when we obſerved, that upon the free contact of the freſh outward air, which was not like the former, deprav'd by moiſt vapours, the matter adhering to the paper quickly ſhone again, and that more vividly than it had done in the receiver.

Obſervations upon a third parcel of the aerial noctiluca.

20. Beſides the liquors that afforded us the foregoing experiments, we ſaved a little of a ſubſtance that was not liquid, yet almoſt as ſoft as mud. This we obtain'd, by pouring ſome of our liquor, taken out of the veſſels, when the diſtillation was ended, into a glaſs funnel, lined with cap-paper; to try, whether it would filtre. But finding that which paſſed thro' too thin and aqueous, the filtre was haſtily wrapp'd up, and put into a ſmall glaſs, but of a moderate wideneſs at the mouth; that both the filtre might be eaſily thruſt in, and the glaſs be exactly ſtopp'd with a ſtrong cork.

21. After other experiments had been made, I carried this glaſs into a dark place; and tho' I could not perceive the leaſt glimpſe of light, yet preſuming that it contained ſome of the true matter of the aerial phoſphorus, and conſequently exhalations, that having been hindered by the ſtopple from flying away, might be kindled or excited by the appulſe of the air; I opened the glaſs, and ſaw an immediate appearance of light, which diſcloſed it ſelf ſometimes upon a leſs, and ſometimes upon a much greater part of the very uneven ſurface of the included paper; and ſeemed to paſs, for a great while, from one part of the filtre, and one ſide of the glaſs to another; with a motion ſo odd and irregular, that it reſembled that of fire kindled by ſparks, ſtruck into a large quantity of tinder: and this ſhining faculty, upon the ingreſs of the air, laſted for many days in the paper.

22. But there was another filtre that afforded us a pleaſing variation of this phenomenon; a larger quantity of matter being wrapped up in the inſide of the paper, or elſe being better conditioned than that which adhered to the former. Having unfolded this paper, and kept it diſplayed in a dark place, we had the pleaſure to ſee a conſiderable number of flames, of different ſizes and figures, diſcloſe themſelves at the ſame time; and tho' moſt of them were vivid, yet few continued long in the ſame place; but they ſeemed frequently to change their ſituations among themſelves, as well as their figures and extent; or elſe new flames inceſſantly broke out in new places, according as the exhalations, that, in plenty, mixed irregularly with the contiguous air in ſeveral places, happened to be, in part, kindled by it; whilſt from the flames themſelves, as well as the unſhining

parts of the filtre, there manifeſtly aſcended plenty of ſmoke, viſible by the light which the ſhining matter afforded; and theſe flames did not keep a conſtant tenor in their blaze, but had their tremblings and emications uſually accompanied with changes of figure, and eruptions of light in ſeveral places at the ſame time; whence 'twas very pleaſant to ſee the whole area of the diſplayed filtre look as the sky ſometimes does, eſpecially in hot countries; when the eye perceives flaſhes of lightning break out in ſeveral places at once: but our coruſcations being more numerous, made the filtre appear almoſt as variegated as marbled-paper; but with this advantage, that the appearance was almoſt perpetually changing; the yellow parts being not only coloured, but lucid; and affording thoſe that looked on them a delightful ſpectacle, as long as we thought fit to gaze on it.

23. Having ſtrongly ſuſpected, that a due agitation of a diſpoſed matter, was one of the chief agents in the production of light; I was lead to try, whether a more intenſe heat, which wou'd communicate a brisk and various motion to a multitude of the corpuſcles of the luciferous matter, diſperſed thro' the liquor, wou'd not do what a fainter agitation was unable to perform. I thought alſo, it deſerv'd to be try'd, whether a conſiderable variation of phenomena would not follow, upon changing the figure and capacity of the glaſs, if all immediate commerce between the cavity of the veſſel, and the outward air, were carefully prevented.

In order to both theſe trials, I took ſome ſpoons-full of aqueous liquor, impregnated with ſome of the more ſoluble portion of the luciferous matter; which liquor, when ſettled, was tranſparent, as containing but an inconſiderable quantity of that muddy ſubſtance. And this clear liquor, which being, as it ought to be for my purpoſe, ſo faintly impregnated, that it would not with ſhaking, or a mild heat, afford any light, was put into a round bolt-glaſs, whoſe ſpherical part was capable of holding three or four times as much; and whoſe ſtem was proportionable in wideneſs to it, and above a foot in length. Having carefully ſtopped this veſſel with a cork, and ſealing wax, 'twas in the night-time ſet ſo, that, by the means of ſand, it might be heated without breaking; and when the ball was made too hot to be well endured in my naked hand, I preſently removed the veſſel into a dark place; and having ſhaken the liquor, perceived a light to break out in the ball, which preſently diffus'd it ſelf thro' the whole cavity, and as ſuddenly diſappeared. Some time after, eſpecially upon ſhaking the glaſs, the light would break out again, and ſoon after vaniſh; and theſe flaſhings of light continued for a while to appear now and then; but were unequal as to their extent, vivideneſs, and duration: and when the liquor grew cold, they entirely ceaſed.

NAT. HIST.

24. But whilſt it was yet conſiderably hot, I thought fit to try, whether, upon breaking the liquor by a ſtrong concuſſion, ſome lucid ſubſtance would not be made to paſs out of the ſpherical, into the cylindrical part; and ſo vary the phenomena. And to this purpoſe, having violently ſhaken the liquor at ſeveral times, with pauſes, I perceived ſome conſiderable portions of the lucid matter to aſcend into the pipe; and particularly once I had the pleaſure to ſee a portion of ſhining ſubſtance, about the bigneſs of a ſmall almond, mount directly upwards like a flame, but not very ſwiftly, from the round part of the glaſs all along the pipe, till it reached the upper part of it. And at other times ſuch flames aſcended into the pipe, but not ſo high; whence many wou'd have confidently inferr'd a poſitive levity in flame; which yet I forbear to conclude, becauſe I once, at leaſt, obſerved, one of theſe portions of ſhining matter, to deſcend from the higher to the lower part of the ſtem; retaining its lucidneſs all the time.

Perhaps, by the way, the phenomena appearing in this glaſs, may illuſtrate, or facilitate, the explanation of what happens in the production and motions of ſome of thoſe meteors, that are called fiery; ſuch as the *ignis lambens*, falling ſtars, frequent lightnings without thunder, and that wandering flame called *ignis fatuus*; ſuch bodies being generated when there happens to be a convention of particles ſo aſſociated, that they mutually agitate each other, or are fitted to be agitated, by a pervading ethereal ſubſtance, and put into a motion, like that which in the portions of our ſhining matter, was able to produce light.

25. Having, by a concuſſion fit for the purpoſe, ſpread, as it were, at once, the liquor all over the inſide of the globe, and part of the ſtem; 'twas pleaſant to behold, how the lucid matter, dividing it ſelf variouſly in its paſſage downwards, adorned the whole cavity of the glaſs, with a company of ſmall, lucid bodies, that both ſhone, and twinkled, like ſo many little ſtars: and the pleaſantneſs of the ſpectacle was increaſed, by their having manifeſt motions, as well as true light. The ſlowneſs of their deſcent in lines, many of them very oblique, made this pleaſant ſight laſt the longer. And this experiment we repeated more than once.

26. Having at another time, in a like bolt-glaſs, carefully given a ſtrong ſhake to the included liquor, when 'twas in a due, but an intenſe degree of heat; I obſerved, that on one ſide of the round part of the glaſs, and above the body of the liquor, there was generated, as it were, a great ſpark of lucid matter, about the bigneſs of a pin's head; whence there was quickly a flame, or light, diffuſed thro' the capacity of the globe, where it ſoon after vaniſhed. From which phenomenon, and ſome others of affinity to it, perhaps it may be argued, that this was a true flame, that from a very ſmall beginning was increaſed by propagation, and kindled the diſpoſed exhalation, it found diſpers'd throughout the cavity of the glaſs; or

that the motion of all light is not neceſſarily inſtantaneous; ſince the progreſs of it was diſcernible, even in ſo ſmall a ſpace as our glaſs compriz'd.

27. To try how long I cou'd preſerve our liquor in a capacity to exhibit ſuch phenomena, without giving it new air, from time to time, but only by keeping in the ſpirituous parts; I cauſed the ſtem to be hermetically ſeal'd; preſuming, that notwithſtanding this, I cou'd, by a certain cautious way of holding the veſſel, ſafely bring the included liquor to an heat ſufficiently intenſe to afford us the phenomena of light; and, in effect, the laſt recited phenomenon, and ſome others, were made in the hermetically ſealed veſſel; and the contained liquor has long continued fit for that purpoſe.

SECT. II.

Small quantities of the noctiluca, excited to perform the office of larger.

THE ſhining matter, contained in our beſt vials, being, at length, partly waſted in experiments, and partly given away; I thought fit to try, whether, by the help of heat, and other motion, our want might not be ſupplied, till more could be prepared.

1. In purſuit of this deſign, I took an old vial, that had long lain by as uſeleſs, becauſe the noctilucal matter had been poured out of it into a ſmaller glaſs; and having held that ſide of this vial, to which I perceived ſome feculent matter ſtuck, near the fire, till it had conceived a conſiderable degree of warmth, I removed it into a dark place; and found it to ſhine vividly, whilſt it retained a competent degree of heat; and when it cooled too much, the light ceaſed with the agitation, that, as a cauſe or a condition, accompanied it. But if afterwards, the vial were again held to the fire as before, the ſhining power would be excited, and the ſplendor continue a pretty while. But after ſome days or weeks, this diſpoſition to be made luminous by external heat, was utterly loſt.

2. Having alſo taken notice of a little feculency, that ſtuck to the inſide of a glaſs, which had contained ſome of our noctilucal matter; I imagined, that though it would not ſhine in the dark by the contact of the air, to which it had been too long accuſtomed; yet when once that diſpirited ſuperficies, that had lain expoſed to the air, was removed; the more internal part of the matter might not be deſtitute of a ſhining power. I, therefore, carefully ſcraped off the outer ſurface, and rubbing a little of the reſt with my finger upon my hand, I found it to ſhine. And though the matter, being once more left expoſed to the air, loſt, in its ſuperficial parts, the faculty of ſhining in the dark; yet thoſe parts being taken off, and the remaining matter rubb'd, it appear'd not deſtitute of a luminous

quality; ſo that it ſeemed, tho' the air did, after a while, mortifie, as it were, and ſpoil the ſuperficial parts that were expoſed to its immediate contact; yet this vitiated ſurface ſerved for a kind of cover, or fence, to the matter that lay beneath it, and kept it from evaporating, or ſpending thoſe ſpirituous or ſubtile parts, on account whereof it was capable of becoming luminous.

3. And as I had obſerved on other occaſions, that liquors abounding in tenacious parts, tho' the liquors did not appear opake or feculent, would leave ſticking to the inſides of the containing glaſſes ſomewhat, that, tho' generally not perceived by the eye, was by ſome other ways diſcoverable; I ſuſpected even in a vial that had formerly contained ſome of our ſhining ſubſtance, tho' it ſeemed to have been well emptied, and to have no groſs feculency adhering to it, there might adhere ſomewhat which might be made viſible by heat or motion; I, therefore, took this glaſs, and having crackt it into fragments, that it might be put into the neck of a vial of a convenient ſhape and ſize, well ſtopt the veſſel, and removed it into a dark place; we there ſhook it, and had the pleaſure to ſee, not only that light was readily produced by the motion excited in the juſtling of the parts one againſt another, but that by reaſon of the various poſition of the fragments of glaſs, the light ſeemed to be vibrated every way, with a very delightful vigour. This production of a kind of blazing light was often repeated with theſe broken pieces of glaſs; and if the vial were heated, the effect ſeemed more ſudden and conſiderable: and even by only warming the vial, without ſhaking it, a light would be produced.

4. Afterwards, having beaten ſome of the glaſs into ſuch ſmall pieces as were capable of paſſing through the neck of a glaſs-egg with a flat bottom, that it might ſtand upright; we hermetically ſealed up the neck, to try whether, by hindering the included matter from exhaling or tranſpiring, we could keep the beaten glaſs always fit to exhibit the phenomenon: but we found not the event anſwer; for after no long time, we could no more produce any light in our ſealed veſſel; tho' an unlucky accident in one of our laſt trials, keeps me from being fully ſatisfied that the thing deſigned is impracticable.

5. Some liquid matter was hermetically ſealed up in a bolt-glaſs, to try whether, by this means, we could, for any long time, preſerve the ſhining faculty of that liquor, wherein it was already exceeding faint, and not to be excited but by a conſiderable degree of heat, and a vehement agitation of the veſſel. This ſealed glaſs having been left in the corner of a window, for a competent time, we at length approached the veſſel, by degrees, to the fire; ſhaking it from time to time, till the included liquor had acquired a conſiderable degree of heat; then removing it to a dark place, and ſhaking the veſſel ſomewhat ſtrongly, we perceived that the diſpoſition the liquor had to ſhine, was very much impaired, but not quite aboliſhed. For there would,

from time to time, upon the rude agitation it was put into, appear little portions of matter that looked prettily, and ſhone very vividly, like ſparks of fire: and ſome of theſe appeared in the ſpherical part of the glaſs, and ſome in the neck. Some of them alſo, ſeemed as it were fixed to their firſt ſtation, and others moved up and down, and moſt of them continued to ſhine for a pretty while before they diſappeared: and when they vaniſhed, few of them did ſo by degrees; but each luminous ſpeck, when it had laſted out its time, loſt is whole light at once.

Obſervations upon a new liquid phoſphorus.

6. Some new liquid phoſphorus being poured into a large vial, that wou'd contain ten or twelve times the quantity; ſo that the ſhining matter, having much air included with it, might thereby be aſſiſted to diverſify, at leaſt, ſome of the phenomena afforded by former noctiluca's: I accordingly obſerv'd in the firſt place, that the ſhining ſteams filled the whole cavity of the large glaſs, that was unpoſſeſſed by the liquor and reſidence; and that this lighter flame continued much longer at once, than any we have hitherto mentioned; for it remained vivid for ſeveral days and nights together, without ever unſtopping the vial to give it freſh air. And I obſerved it to do ſo for about a week, before my occaſions hindred me from regarding it any longer

7. I ſometimes took notice, that ſome exhalations or vapours, that appeared conſiderably luminous, ſeemed to roll to and fro, like little clouds or aggregates of ſmoak in the cavity of the veſſel; tho' it ſeemed difficult to determine what ſhould give and maintain ſuch a motion in them.

8. The largeneſs of the glaſs being conſiderable, it happened that, ſometimes, when I went into the darkned place where I kept it; ſo much luminous matter would yield a ſurprizing ſight; but tho' its extent were far greater, yet its intenſeneſs did not much exceed that of the light afforded by noctiluca's of the firſt ſort, as we may call thoſe formerly mentioned. Only this I often took notice of, that, in caſe I ſhook the matter gently, the light would appear much more vivid, and, as it were, flaſh, on and about the ſurface of the liquor where it was contiguous to the air, more than it did elſewhere. And this ſplendor was ſuch, that if it had been laſting, I thought it would have made our phoſphorus uſeful for conſiderable purpoſes.

9. When after having, for many days, kept this glaſs ſtopt, ſo that, at laſt, it would no longer ſhine of it ſelf; we ſuppoſed it to be reduced to the condition of a phoſphorus of the firſt ſort, and accordingly found, that, upon the removal of the ſtopple, and ingreſs of freſh air, the cavity would, in a moment, be filled with fumes that look'd white in an enlightned place, but luminous in a dark one; and (probably by reaſon of the quantity of the air contain'd in ſo capacious a glaſs) the light uſually continued much longer than in noctiluca's of the firſt ſort.

10. Being deſirous to try, whether this more vigorous matter, if it were kept ſo exactly ſtopped, that none of the luminous vapours could exhale, would not laſt very long; I put near two ſpoonfuls of the liquor, with ſome of the ſediment, into a bolt-glaſs (with a flat bottom) capable of containing near twice the quantity: this glaſs being hermetically ſealed, the included liquor continu'd to ſhine without any external help, either of air or heat, for about ſix days and nights; but then it ceaſed, nor would be made luminous again by moderate ſhaking.

11. After having poured out ſome more of the liquor and ſediment that had been kept in our great vial, into a ſmaller; the remaining matter, having now a greater proportion of air included with it, was very apt to be put into a luminous agitation; and would emit exhalations, that not only fill'd the cavity of the glaſs, but manifeſtly moved to and fro in it, after an odd manner. And being one night willing to give a lady, and ſome other company, the diverſion of a new phenomenon; after having opened the vial, and then ſtopt it again, I ſhook it, and turned it ſo, that, much the greateſt part of the liquor having been before poured out, the reſidence was ſpread over the inſide of the glaſs, to which its particles ſtuck, becauſe there wanted liquor enough to waſh them down: by this means, thoſe little portions of the ſediment being not covered, as uſual, with water, but expoſed to the immediate contact of the air, ſhone much more vividly than the luminous exhalations; and the light being tremulous and twinkling, as well as briſk, they ſeemed to reſemble ſo many little ſtars in a clear dark night, and continued this ſparkling longer than one would have expected, to the delight of the ſpectators; for whoſe ſake the experiment was ſeveral times repeated, and with ſucceſs.

The properties of a new icy noctiluca, or ſolid ſelf-ſhining ſubſtance.

12. Having, at another time, but by a like method, obtained a ſelf-ſhining ſubſtance of a conſiſtent form; I proceed to give ſome account of what I obſerved about it.

(1.) And firſt, tho' this uſually came over in diſtillation, in the form of many little grains, or fragments, differing, for the moſt part, from one another, both in bigneſs (ſome being of the ſize of grains of corn, and others of peaſe, or large cherry-ſtones) and ſhapes, which moſt commonly were irregular; yet when the diſtillation was carried on proſperouſly, we obtain'd the deſired matter in greater lumps; ſometimes as large as ſmall beans, and at others, three or four times as large, but not proportionably thick.

(2.) Theſe lumps, whether ſmall or great, were colourleſs; and uſually when held againſt the light, tranſparent; ſo that many bodies placed beyond them at a convenient diſtance, might be plainly ſeen through them. And ſome of the larger appeared ſo like ſuch fragments of ice, as being thin, are often very clear, and almoſt quite deſtitute of manifeſt bubbles; that becauſe of this great reſemblance, and for diſtinction ſake, I thought it not amiſs to call our conſiſtent ſelf-ſhining ſubſtance, the icy, or glacial noctiluca, or phoſphorus.

(3.) But when I ſay, that our noctiluca is tranſparent and colourleſs, I mean it only with regard to what uſually appeared. For whether it were any real difference in the texture, or conſtitution, of the body it ſelf, or the effect of ſome caſual junctures of circumſtances; but ſometimes, eſpecially by candle-light, ſome leſſer fragments appeared not diaphanous, nor always either colourleſs, or of the ſame colour; but ſometimes reddiſh, ſometimes of a faint, but pleaſing blue; and ſometimes too, of a colour to which I cannot eaſily aſſign a name.

(4.) Our icy noctiluca, or phoſphorus, is manifeſtly heavier *in ſpecie* than common water; in which being put, it readily ſinks to the bottom, and quietly lies there.

(5.) This ice-like body, though conſiſtent, is not hard; being far leſs ſo than common ice; yet 'tis not ſo ſoft, but that 'tis brittle; and will more eaſily be broken in pieces by the preſſure of one's fingers, than receive a ſhape from thence; however, it may, with care, be ſpread upon a ſolid body, almoſt like unmelted tallow.

(6.) The conſiſtent phoſphorus is fuſible enough. For though in the air it will not be brought to melt, without ſome difficulty and waſte; yet by the help of hot liquors, and even of water it ſelf, it may, with a little dexterity, be diſſolved; which is an obſervation of good uſe; becauſe, by means of fuſion, ſeveral fragments, if the matter be pure enough, may be brought to run into one lump; and in that condition may both be the better preſerved, and become fit to be applied to ſome conſiderable uſes, which cannot ſo well be made of leſs, though numerous fragments.

(7.) This glacial noctiluca is, as to ſenſe, cold; but of a texture that diſpoſes it to be eaſily agitated; and by agitation it becomes hot. And when this ſolid noctiluca is held in the free air, though perhaps its ſuperficies be wet, it affords a very vivid light, uſually ſurpaſſing that of the aerial noctiluca; and this light ſeems to proceed from, if not alſo to reſide in, the body it ſelf.

(8.) When our icy phoſphorus is taken out of its receptacle, and expoſed to the immediate contact of the free air, it uſually emits a wonderful deal of ſmoke, diſcernable by the light of the body it aſcends from; and this plentiful emiſſion uſually laſts as long as the phoſphorus is kept in the air.

(9.) But 'tis pleaſant to obſerve, and deſerves to be conſidered, that as ſoon as plung'd in water, ſo as to be quite covered with that liquor, it ceaſes not only to ſmoke as before, but to ſhine; as if a thorowly kindled coal were ſuddenly quenched in water. And were it not for this, our noctiluca would be quickly waſted; but the water, fencing it from the contact of the air, keeps it from ſpending it ſelf as formerly; and yet does really make but a ſeeming and temporary extinction of this ſtrange fire. For as ſoon as 'tis again taken out of the water, (though it have lain very long there) it falls to ſhine again, even whilſt 'tis yet dropping wet.

And I have ſometimes obſerved, that when I had ſo large a piece of noctiluca, that I could conveniently hold one half of it under the ſurface of the water, and the other half above it, whilſt the immers'd part afforded no light, the extant part ſhone vividly.

Obſervations upon the water wherein the ſolid noctiluca [illegible] *kept.*

13. Conjecturing that the water wherein this noctiluca had been long kept covered, to defend it from the air, though it did not manifeſtly diſſolve the maſs, might yet be impregnated, at leaſt, with the more ſaline, and ſoluble parts of it; I thought fit to make a few trials upon this liquor.

And firſt, I found that it had a ſtrong and piercing taſt, like that of ſea-ſalt; but more pungent, as if brine were mixed with ſpirit of ſalt: and it reliſhed alſo ſomewhat of vitriol.

14. Being put into a ſmall, concave veſſel of refin'd ſilver, upon lighted coals and aſhes; it evaporated but very ſlowly, and would not be brought to ſhoot into cryſtals, nor to afford a dry ſalt; but coagulated into a ſubſtance, ſometimes like a gelly, and ſometimes, as to conſiſtence, like the whites of eggs: which ſubſtance was eaſily melted by heat.

15. When this ſubſtance was kept a while on a hotter fire, it only boiled at firſt, but ſoon after began to make a crackling noiſe; whilſt the exploſions were accompanied with flaſhes of fire and light; which, if ſmall, were generally very blue, like the flames of ſulphur, but more vivid, and ſometimes alſo more blue; but the greater cracks, whoſe noiſe was conſiderable, gave a yellow colour, and a very ſtrong light. And theſe phenomena did not only happen whilſt the matter was boiling over the fire, but a pretty while after the veſſel was taken off, and held in the air.

16. If, before the coagulated matter was too far waſted by the heat, it were ſuffered to cool a little, it appeared to have acquired a conſiſtence like melted roſin, or rather, ſtiff bird-lime; for it would draw out into threads of, perhaps, a foot, or more, in length; and having held one of theſe threads to the flame of a candle, it did not take fire, but melted into little globules, like capillary threads of glaſs. And having made ſome of them ſtick to the wieck of a candle, towards the bottom of the flame; they coloured the lower part of the flame, quite round, with a very fine blue, which laſted much longer than one would have expected.

17. This glutinous ſubſtance had, by the action of the fire, acquir'd an odd kind of ſtrong ſmell, almoſt like that of garlic; and being left all night in the air, attracted the moiſture of it exceeding faſt; appearing diſſolved, in a great meaſure, into a liquor almoſt as ſtrong as ſpirit of ſalt.

18. Putting this ſubſtance again over the fire, as before, it appeared to be very fix'd; for though there were not ſo much as a ſpoon

full of it, yet it continued boiling for a great while, and afforded a multitude of ſhining exploſions, ſome whereof made a conſiderable noiſe, and gave notable flaſhes of light, which ſeemed to proceed from condens'd and agitated fumes, ſuppreſſed by the hardned ſurface of the matter, and kindled in their eruption into the air; whither ſome parts of theſe fumes, that were not kindled, eſcaped, in the form of ſmoke, whoſe ſmell was very ſtrong and rank, but of a peculiar kind. And what ſeemed ſtrange, though often two, and ſometimes more flaſhes appeared at once, yet ſo ſmall a quantity of matter continued to afford them for almoſt an hour together; and, probably, would have done ſo longer, if I could have watched it.

In what liquors the icy noctiluca is, or is not diſſolvable.

19. Among other ways of diſcovering the nature of our icy phoſphorus, I thought fit to try, whether it would diſſolve in ſome liquors of different kinds, from whence we might gueſs at its texture.

We found then, that common water would not, in the cold, diſſolve it, though the liquor was thereby impregnated; as when *Crocus metallorum*, or glaſs of antimony, being infuſed in wine or water, the menſtruum is impregnated with emetic particles; tho' the bulk, ſhape, and colour of the *crocus*, or the glaſs, are not thereby viſibly diminiſhed or altered.

20. We afterwards put a grain or two of our lucid matter, into a little ſpirit of ſal-armoniac; but this ſeemed not to make any conflict with it, nor manifeſtly to work upon it; though, to give the liquor time to make a ſolution, we left them together for ſeveral days. But as ſoon as we had poured off the ſpirit, it appeared that it had not by any contrariety, deſtroyed the power of the noctiluca, which began readily to ſhine as formerly; and yet might be immediately ſuppreſſed again, by ſuffering the liquor to cover it as before; but when we had, by keeping the vial, for ſome time, in a moderate heat, impregnated the liquor with it; this liquor, being then dropt into water, had a like effect with that hereafter to be mentioned in the experiment with impregnated ſpirit of wine.

21. Seeing a volatile and urinous ſalt would not work ſenſibly upon our phoſphorus, we thought fit to try, what corroſive liquors would do; and accordingly, put a grain or two of our ſplendent matter into a very ſmall vial, wherein was a little oil of vitriol; that menſtruum appearing, in many caſes, more corroſive than other vulgar acids; but neither did this menſtruum diſſolve our icy noctiluca, in the cold; and therefore putting it in ſome heat, we found, that though it did not manifeſtly diſſolve the ſhining matter, yet the warmed oil made it melt, and appear, at leaſt for the time, a fluid body; in which it ſeemed remarkable, that this ſo fugitive a ſubſtance, ſhould be ponderous enough to lie at the bottom of oil of vitriol; one of the heavieſt fluids we know, except quick-ſilver.

22. Afterwards we put a ſmall fragment of our icy phoſphorus, into *Aqua fortis*; and though we kept it in that menſtruum for two

or three days, and ſet the containing vial, for many hours, in a warm place; yet we found the matter ſo little altered, as to its viſible appearance, that we doubted, whether the liquor had diſſolved any ſenſible quantity of it.

23. I put a little of our noctiluca into ſome oil of turpentine; which not diſſolving it in the cold, the ſmall vial that contained it, was left all night upon warm aſhes. But though the next day none of the phoſphorus appeared any longer in the glaſs, yet we could not perceive, by two or three different trials, that the oil was much altered by it; and particularly I obſerved, that though the glaſs was unſtopt, and kept ſo for a while, yet the ingreſs of the air did not produce any ſenſible light: nor did we perceive the upper part of the glaſs to be full of white fumes, as is uſual in ſeveral other liquors impregnated with our noctiluca, when they are unſtopt.

24. It has rendred the experiments made with the aerial noctiluca, much leſs acceptable, than otherwiſe they would have been, to the delicate ſort of ſpectators, that the light produced, was accompanied with a very unpleaſant ſmell, that iſſued out of the vial whenever it was unſtopped, to let in the air. But by the help of our icy noctiluca, I found a way to prevent this ungrateful concomitant of our artificial light. For having, in a very ſmall vial, put about a grain of noctilucal matter, and covered it with as much pure eſſential oil of cinnamon, as wou'd ſwim leſs than a finger's breadth above it; we carefully ſtopt our little vial, and having warily held the bottom of it againſt a fire, till the phoſphorus began to melt, I ſuffered it to cool; and then unſtopping it in a dark place, had the pleaſure to ſee a vaniſhing indeed, but a vivid light. So that, by this means, I could afterwards ſhew the production of light to the niceſt perſons; adding to the pleaſure of a delightful phenomena, that of a fragrant ſmell. But becauſe oil of cloves is more eaſie to be had good, than the oil of cinnamon, and is alſo much cheaper, I tried the experiment more fully with that.

25. We put ſome of our luminous ice, into a little pure oil of cloves; but found, after a conſiderable time, that, at leaſt, a great part of the matter was undiſſolved; yet the liquor was richly impregnated with it; as we found by a pretty phenomenon that it afforded us. For the little vial it was kept in, being opened in a dark place, there immediately enſued a kind of flaſh of light, far more vivid, its ſmall bulk conſidered, than any liquor had yielded us before. But the brightneſs of this appearance was, it ſeems, too great to be laſting; for the flame-like ſubſtance uſually expired in leſs than a minute; and ſometimes, perhaps, in half that time. And there were two other circumſtances particular enough in this phenomenon; one, that ſometimes, eſpecially if a candle were in the room, the ſhining fluid would appear of a pleaſant, and ſomewhat ſurprizing bluiſh colour: the other, that the light would ceaſe, whilſt there

yet remained in the upper part of the glaſs, many whitiſh fumes, ſuch as we have formerly often obſerved in the aerial noctiluca, to be the uſual cauſes or concomitants of light; as if in our preſent caſe the ſhining ſubſtance prey'd on, or reſided in only the finer and more delicate particles of the whitiſh exhalations.

26. Inſtead of the oil of cloves, we ſubſtituted ſome chymical oil of mace, into which we put a competent quantity of the glacial phoſphorus; but though we warmed the bottom of the vial as much as we judged neceſſary, yet, upon unſtopping of it, there appeared no ſign of light, though the trial was made more than once or twice, and ſometimes with favourable circumſtances: which event was the leſs expected, becauſe the oil made uſe of, was preſented me as very pure, by the ſame traveller who gave me that of cloves before mentioned; and becauſe alſo the warmed phoſphorus was ſo well conditioned, that as ſoon as ever the oil was removed, it ſhone with an extraordinary vigour.

27. We made alſo a trial or two with diſtilled and fragrant oil of aniſeeds, to ſee, if, that being an eſſential oil, and looked upon as a kind of aromatic one, it would better diſſolve the noctiluca, or be impregnated by its luciferous parts; but we found, that it neither diſſolved the matter, nor, upon unſtopping the containing vial, afforded any light, or ſo much as whitiſh fumes; which ſeemed ſomewhat ſtrange, becauſe the oil was very ſubtile, and by its aptneſs to coagulate of it ſelf, ſhewed that it was genuine; and not, as common chymical oils too frequently are, ſophiſticated.

28. Having no more oils fit for my turn, I next tried, whether I could diſſolve our ſhining matter in ardent ſpirits, which are thought to be near allied to diſtill'd oils; and having, accordingly, put ſome of our icy phoſphorus into ſpirit of wine, though the menſtruum in quantity, ſome hundreds of times exceeded the body 'twas to work upon, yet after ſeveral days, wherein it ſtood in a window, expoſed to the ſun-beams, in the hotteſt part of the ſummer; it appeared undiſſolv'd at the bottom of the liquor, and ſcarce ſenſibly diminiſhed.

Light ſuddenly produced in common water, by the help of a liquor not luminous.

29. We weighed in a tender balance, one grain of our glacial phoſphorus, wiped dry, and broken into four or five pieces, for the eaſier diſſolution thereof. And to theſe, in a cryſtalline vial, we put a convenient quantity of highly rectified vinous ſpirit; and ſtopping the vial cloſe, we ſuffered it to remain for many hours, ſometimes in the cold, and ſometimes in the ſun; but perceived not that near a total diſſolution was made of the noctilucal matter; even one of the leſſer fragments appearing, as well as the others, undiſſolved in the bottom of it. However, ſince a body conſiſting of ſuch ſubtile parts, may communicate many of them to a contiguous liquor, without any diminution of its bulk, obſervable by the eye; I thought fit to try what effects this body had upon the vinous ſpirit.

30. And firſt, I obſerved, that it did not manifeſtly diſcolour the liquor, but left it tranſparent and limpid, as before; only there appeared ſome very ſmall earthy corpuſcles, like duſt at the bottom of the liquor, when being a little ſhaken, it was attentively view'd.

31. We did not obſerve that, upon unſtopping the vial, and the reſtored commerce between the inward and outward air, there appeared any flame or luminous exhalations, as is uſual upon opening vials that contain the liquid aerial noctiluca.

32. But having, in a dark night, dropt a little of this impregnated ſpirit into a ſmall *China* cup, with common water in it; tho' the ſpirit neither in the vial, nor in its paſſage through the air, diſcloſed any degree of light, yet as ſoon as ever the drops came to touch the liquor, they would be as it were kindled by the cold water, and afford little flaſhes of light, more vivid than the noctiluca it ſelf; giving a ſplendor that render'd not only the brims of the cup, but many of the neighbouring objects manifeſtly viſible. Theſe coruſcations had the property of other lightning, to vaniſh almoſt as ſoon as they appeared; nor would the water, that produced them, by being agitated, ſhine; but others might immediately be produced, by letting freſh drops fall into the ſame water; upon whoſe ſurface they ſeemed to diffuſe themſelves; and they would ſometimes leave thereon, for a little while, a faintly luminous film or membrane.

I alſo thought fit to try, whether our phenomenon would not be produced with hot water as well as with cold; and accordingly found that the impregnated ſpirit of wine produced rather a greater than a leſs light in hot water than it had done in cold.

33. At another time, having, in a very good balance, weighed out one grain of our noctiluca, (firſt wiped dry) we put to it, at ſeveral times, that it might the better diſſolve, above two thouſand grains of ſpirit of wine, that would burn all away; and yet, which may ſeem ſtrange, this ſmall quantity of noctilucal matter did ſo impregnate all the liquor put upon it, that tho' nothing of luminous appeared in the menſtruum, nor in any exhalations riſing from it, if the vial were unſtopped, or the liquor poured out of it into the air; yet as ſoon as ever 'twas dropt into common water, there would be produced a vivid appearance of light, ſuch as we lately mentioned.

It ſeemed not very improbable, that theſe ſudden and vaniſhing flaſhes might, in great part, proceed from the quick diſengagement and extruſion of the noctilucal particles, made by the water; which, diluting the vinous ſpirit, diſabled them from retaining the luciferous corpuſcles: as if into one ounce of high rectified ſpirit of wine, you put half a dram, or a dram of camphire, the liquor will diſſolve it, without being thereby manifeſtly altered as to colour or tranſparency; but if you drop this ſolution into common water, the vinous ſpirit will immediately diffuſe it ſelf into the liquor, and let go the corpuſcles of the camphire, which float like a white powder upon the ſurface of the water. And, accordingly, our impregnated ſpirit of wine being dropt into ſome other well deflegmed ſpirit of wine, we ſaw no light produced; but when it was dropt into ſpirit of ſal-armoniac, which ſeems to conſiſt of the volatile ſalt diſſolved in the phlegm or aqueous liquor, the noctilucal corpuſcles were by this wateriſh part freed from the vinous ſpirit, almoſt as much as they would have been by common water, and did, accordingly, ſhine with much briskneſs.

A ſtrange ſubtilty of parts in the glacial noctiluca.

34. And after having brought one grain of our ſhining matter to impregnate between four and five ounces of highly rectified ſpirit of wine, which did, at leaſt, two thouſand times exceed the weight of the noctilucal ſubſtance; I preſum'd that this very parcel of ſpirit of wine, wherein it was already diffuſed and ſcattered into ſo many thouſand corpuſcles, as ſufficed to impregnate all the liquor, would yet communicate to a large quantity of water particles enow to make it ſhine, when agitated. Wherefore, when we had weighed out, in a very exact balance, one dram of our impregnated ſpirit, we mixed it with, and ſhook it in as much fair water as we thought fit, (but not all at once) till we had to our dram of ſpirit of wine, put above fifty time its weight of water; and this ſpirit it ſelf weighing, at leaſt, two thouſand times as much as the noctilucal matter, wherewith 'twas impregnated, it follows, that the ſingle grain of icy noctiluca was able to diffuſe it ſelf through, and impregnate full a hundred thouſand grains of liquor, ſo as (when duly ordered) to make it luminous. For having preſently after the laſt water was put into the glaſs, ſtopt the veſſel cloſe with a cork, and ſhaken it a little in a dark place, the whole vial appeared to be full of light; which tho' it were not more than ordinarily intenſe, yet by reaſon of the bulk of the liquor, made a glorious ſhew, and diſcovered many of the neighbouring objects. And after we had done ſhaking the vial, not only the upper part, which was fill'd with exhalations and vapours, ſhone like thoſe other liquid phoſphori formerly mentioned; but, what was not obſerved in them, the water it ſelf had a luminouſneſs, tho' of an inferior degree, of its whole maſs; for when the glaſs was ſhaken, all the liquor appeared to ſhine, ſo that we could plainly ſee through the ſides of the veſſel, the conical figure of its bottom.

After this, I proſecuted the experiment further, increaſing the proportion of the water to freſh impregnated ſpirit; and found, that one part of the noctiluca, being firſt diſſolved in ſpirit of wine, and afterwards briskly ſhaken into a convenient quantity of water, rendred as much liquor luminous, as, upon calculation, amounted to four hundred thouſand times its weight. And this did not ſeem to proceed from the irradiation of the luminous corpuſcles or exhalations, ſhining in the empty ſpace at the top of the glaſs; becauſe the vial was ſo near fill'd with liquor, that there was but little room left for vapours; and becauſe, alſo, the vapours that play'd in that ſpace, ſhone but very faintly; and when the glaſs was at reſt much leſs than a minute, the light would reach but a little way downwards in the water, and yet was there ſo dim, as to be ſcarce diſcernable. But in our experiment, not only the agitated liquor appeared luminous throughout, but the light was briſk.

But leſt ſome ſhould think, that if this experiment had been ſtill further proſecuted, the luminouſneſs would have ſtill extended to greater quantities of water; I ſhall add, that when I increaſed the proportion of this liquor to the noctilucal matter, to be diſperſed through it, by putting in near three or four ounces of water, more than I gueſſed would be convenient; the luminous matter ſeemed to be, as it were, drowned or loſt in ſo much liquor; for tho' we gave it much more agitation than had, in the former experiments, produced light; yet no luminouſneſs at all appeared in the freſh ſpirit: and ſhaking it into ſuch a quantity of water, as I thought it might ſerve to impregnate, I found that the luminous maſs of liquor, thereby produced, amounted to more than five hundred thouſand times the weight of the noctilucal matter diſperſed through it; which is a viſible expanſion very much greater than, I think, has been hitherto obſerved in any corporeal ſubſtance diſſolved in a viſible liquor; ſince it four times exceeds that I made with cochineal, and which has been taken notice of as a prodigious thing; one part of the cochineal, having in that experiment produced a diſcernable colour in an hundred twenty five thouſand parts of water.

But I here only deliver the manifeſt impregnation of the water it ſelf, which is a groſs and tangible liquor, by the diſperſed particles of the noctilucal matter; and have made no eſtimate of the incomparably greater expanſion of the light, that from the matter included in the vial, illuminated the ambient air, to a conſiderable diſtance from it; tho' by reaſon the darkened room was not large, I was diſabled to make an eſtimate how far the enlightened ſphere of air might have extended.

Beſides, this experiment was not favourably made; ſince we purpoſely weighed out ſomewhat leſs of the lucid matter, and now and then more of the water, than the preciſe quantities our calculation ſuppoſes.

And laſtly, upon ſearch I found, that the grain of icy phoſphorus, firſt put into the ſpirit of wine, we made uſe of all this while, was not, tho' after ſo long a time, totally diſſolved; a ſmall fragment, amounting to about an eighth part, if not more, remaining at the bottom of the vial; upon which having poured ſome freſh ſpirit of wine, and kept it a while in a little heat, to further the diſſolution; that liquor grew very luminous, when dropt into common water: whence it ſeemed probable, that if the whole grain of icy phoſphorus had been diſſolved at firſt in the ſpirit of wine, it would have impregnated above ſix hundred thouſand times its weight of water, ſufficiently to make it ſhine.

I come now to another way, by which I thought the great ſubtilty of parts in our noctilucal matter might appear with good advantage.

35. We carefully weighed out a ſmall lump of the ſhining matter, amounting to three grains; and having purpoſely broke it into ſeveral leſs fragments, perhaps ſix or ſeven, we laid them upon a flat-bottom'd glaſs, that was broader at the top than the bottom, and ſhallow too, that the matter might be more fully expoſed to the free air. This glaſs we placed in a ſouth window, laying it very ſhelving, that the liquor to be produced, by reſolution in the moiſt air, might preſently run down, and not hinder the free evaporation of the remaining matter. The veſſel being thus placed, at about ten of the clock at night, all the fragments of the noctiluca ſhone briskly, and ſo continued, till moſt of them were reſolved into other ſubſtances; the biggeſt of them continuing ſhining, while the others were reduced to ſuch a ſmallneſs, that they would ſcarce have been ſeen, had not their own light made them viſible. But the principal thing in this experiment is, that ſo little a quantity of noctilucal matter, continued to emit viſible fumes, for many more than an hundred and fifty hours; and this with circumſtances that made the thing more ſtrange.

For firſt, the ſmoke was not only viſible, but manifeſt; and that as well in the night, as in the day.

Secondly, the ſeveral parcels of matter did each emit theſe fumes all at once, as if it were from ſo many little chimneys.

Thirdly, this ſmoke was ſo large, and withal ſo tenacious, that it would eaſily retain the form of ſmoke, at a conſiderable diſtance from the bodies that emitted it; ſo that as I walked in the room, a careleſs look towards the glaſs would often diſcover it; and ſometimes it would manifeſtly appear at a diſtance, that I eſtimated to be near a foot from the matter which afforded it.

Fourthly, the motion of the ſmoke was ſwift, conſidering that it had no channel to aſſiſt it: and it was not always, nor for the moſt part, directly upwards, but ſometimes horizontal, ſometimes downwards, ſometimes towards the right hand, and ſometimes towards the left; as if the motion of the fumes had been determined by the ſituation of thoſe parts of the noctilucal fragment, by which they were emitted, and as 'twere diſcharged. And indeed, I thought, I many times obſerved a kind of palpitation, or eſtuation, in the little ſhining fragments; which I gathered from the apparent great inequality in the plenty of the ſmoke emitted at ſeveral times; all of them, perhaps, within the compaſs of a minute or two.

And laſtly, even in the latter part of the experiment, after the ſhining matter had been ſo long expoſed to the air, it emitted a ſtrong ſmell; which ſeemed to be cauſed by odorous exhalations, diſtinct from the viſible fumes.

36. Now as I had ſet the glaſs, and kept it in a ſhelving poſture; I thereby preſerved the ſaline part of the ſhining matter, a liquor which I thought fit to examine.

In order to this, I put all the remaining clear liquor, or *Caput mortuum*, into a ſmall concave veſſel of well-refined ſilver. And our liquor being, in this veſſel, ſet upon ſome ſmall coals and aſhes, did not evaporate near ſo eaſily, as one would have thought; but turned into an unctuous ſubſtance, of a dark reddiſh colour; wherefore, we placed the veſſel upon quick coals, that by their briſk heat they might make the liquor boil, and free it from ſuperfluous moiſture. By this means, after a while, it was reduced to a ſubſtance, that afforded us a pretty phenomenon. For the boiling liquor crackled like a handful of bay-ſalt caſt into the fire; and whilſt theſe cracklings continued, which they did much longer than one would have expected, they imitated little volleys of ſhot, not only in the great number of the ſounds they made, but in the little flaſhes that accompanied them; which, when the fire was ſomewhat increaſed, were ſo many, and followed one another ſo faſt, that they appeared to make up a continued flame, pleaſant to behold.

37. I had, afterwards, a mind to make ſome eſtimate, how far the breaking of the ſhining matter into fragments, and the conditions of the veſſel, contributed to the quick conſumption of it. To this purpoſe, we took a lump of three grains, carefully weighed out, and put it into a ſmall glaſs funnel, whoſe upper end was wide and capacious with regard to the lower part, which was exceeding ſlender, that the noctiluca might have air both above and often below; yet the matter not ſlide down, till it were ſo waſted, as to be leſs than a ſmall pin's head. A veſſel of this ſhape I choſe to make uſe of, that I might catch the liquor, that would be afforded by the deliquation of our icy phoſphorus; for which purpoſe the ſlender pipe of this funnel was put into the orifice of a ſmall cylindrical vial, and there kept in a quiet place, which was a ſouth window; from whence every night, after I was in bed, I cauſed it to be brought into my chamber, to ſee if it continued to ſhine. By which trials, I found that it remained luminous, and was not yet ſo waſted, as to fall quite through the funnel into the vial, at ſomewhat beyond the end of the fifteenth day; ſo that it continued to ſhine for three hundred and ſixty hours.

What has been hitherto related, may juſtly make a man reflect, with ſome wonder, upon the ſtrange minuteneſs and multitude of parts, that are crowded together in our noctilucal matter; if we conſider what a multitude of luminous beams of viſible ſmoke, and of odorable effluvia, ſo ſmall a quantity of it as three grains, could inceſſantly afford for two or three hundred hours; leaving, after all this, behind it above three times its weight, (for ſo we found it to be) of a liquor, which it ſelf was not a cadaverous one; or, what it looked like, common water; but was, very probably, impregnated with many ſaline parts, and not a few capable of ſhining briskly.

The inflammability of the noctiluca it ſelf.

38. I took a little of the conſiſtent noctiluca, and having broke it, and, as its brittleneſs would permit, ſpread it here and there upon a piece of folded paper; I lighted that paper at the flame of a candle, and obſerved, that when the flame reached any little fragment of the ſhining matter, it would take fire, and burn away in a flaſhing and very ſputtering manner, accompanied with noiſe; almoſt like grains of ſalt-petre, when thrown upon a live coal.

39. I obſerved alſo, that if I put pieces of paper, on which I had placed ſome of theſe grains of noctilucal matter, upon ſome embers covered with aſhes; before the paper it ſelf took fire, the ſhining matter would communicate its flame to the contiguous paper.

40. We put a fragment of our ſhining matter, not amounting to a grain, into half a ſpoonful, or leſs, of highly rectified ſpirit of wine, and kindling that liquor with the flame of a candle, the ſpirit burned away, as is uſual, in a flame partly yellow, but chiefly blue: and though the heat of the ſilver-ſpoon, wherein the trial was made, quickly melted the noctilucal matter, and gave it a globular form; yet it continued at the bottom, without manifeſtly mixing with the vinous ſpirit, or conſiderably altering the colour of its flame. But when the ſpirit of wine was all conſumed, without leaving the leaſt phlegm behind it, the laſt drops coming, when they were actually kindled, to touch the ſhining matter, they preſently ſet it on fire; but its flame was very different from that of the vinous ſpirit: for, beſides ſomewhat odd in its figure, its colour was not at all blue, or bluiſh, but of an intenſe yellow; and burned ſo fiercely, and with ſo vivid a light, that it was ſurprizing to behold: it alſo continued to burn for a pretty while, conſidering the ſmall quantity of the combuſtible matter. And whilſt it burned, it emitted plenty of ſmoke, that ſeemed to be darted up to a conſiderable height. The matter did not burn all away, at once, but left a kind of *Caput mortuum*, which lay in the form of a little cake, partly of a deep yellow, and partly of a fine red. This matter being very bulky, in proportion to what was conſumed, I proceeded to burn it after another manner, till there remained only ſome very few light feces, that ſeemed to be of the ſame nature with thoſe in the following experiment.

41. We took a ſmall fragment, not amounting to a grain, of the noctilucal matter, and putting it into a ſilver-ſpoon, we caſt upon it the ſun-beams collected by a ſmall burning glaſs; whereby it was preſently ſet on fire, and afforded, together with a great deal of ſmoke, a flame exceeding yellow, and ſo very fierce and bright, that it was conſpicuous, though, the window being purpoſely ſet open, the beams of the ſun, then in the meridian, were ſuffered to beat full upon it: a brisk wind alſo blew upon it without extinguiſhing it.

At the bottom of the ſpoon, the expiring flame left a round and broad *Caput mortuum*, conſiſting of ſeveral circles, like thoſe of a ſardonyx, the largeſt whereof was white, another yellow, and the third red; all the three colours being pleaſant and vivid. Some part of this *Caput mortuum*, being freely touched by the air, appeared combuſtible; and the reſt being left in the ſpoon, that the air might work upon it, did, for the moſt part, ſoon reſolve it ſelf *per deliquium* into a liquor, almoſt as ſharp as ſpirit of ſalt; the reſt remaining a light black feculency; of which, becauſe there was ſo very little, we could make no trial. But ſo much matter could not be left unfired, unleſs ſomething hindered its accenſion; for when we warily turned over the little cake with the point of a knife; the under part, being, I preſume, hot, preſently took fire upon the contact of the air, and flamed away, till the matter was almoſt totally conſumed.

42. We put two grains of our dried noctilucal matter into a glaſs mortar, whoſe coldneſs and thickneſs were able to keep it from being put into any ſenſible heat, by the operation that was to be performed in it; and conſequently, from communicating any heat of its own to the noctilucal matter. This we pretty briskly rubbed in the mortar, with a glaſs peſtle; but though it was thereby brought to ſhine much more vividly than before, yet it did not take fire; which I was apt to impute to the great coldneſs of the glaſs; but at length it took fire, and began to burn away in an actual flame, with much ſmoke: this, however, did not laſt ſo long as might have been expected; probably, becauſe the veſſel continued ſenſibly cold; and perhaps alſo, becauſe of the narrowneſs, and depth of it, which ſomewhat hindered the free acceſs of the air; for ſome matter, that was taken out on the peſtle, ſeemed to burn better than that which remained in the mortar; and this being extinguiſhed, was once more kindled by trituration; but ſoon expiring again, could not by the ſame means be re-kindled, only it ſhone briskly.

Experiments about burning other bodies with the noctiluca.

43. If our phoſphorus be for any time preſſed hard between the fingers, or againſt a board, or ſome ſuch hard, and not very cold body, it will often feel actually and very ſenſibly hot; and ſometimes the degree of heat will be ſo vehement, as to ſcorch the skin, as my venturous aſſiſtant found ſeveral times to his pain; his fingers being almoſt covered with bliſters, raiſed on them by handling our ſhining matter: he alſo complained to me, that, though he had been often burned on other occaſions, yet he found bliſters excited by the phoſphorus, more painful than others; and he is not the only perſon, who has complained of finding the burns made with this matter, to be more tedious and difficult of cure than ordinary ones. But, as our noctiluca was not always made of the ſame matter, nor with care equally ſucceſsful; ſo I obſerved its diſpoſition to burn, and the degrees of heat, to which it would be brought by motion, to be different; upon which account, I did not find, that

ſome portions of it, would produce thoſe higher effects of heat, that others did; beſides, theſe higher effects gradually differ'd among themſelves.

44. And accordingly, after having in vain tried to fire paper, by preſſing and rubbing ſome of our phoſphorus upon it with the blade of a knife; I took a piece of fine paper, and having dry'd, and warm'd it at the fire, I put a little of our noctiluca in a fold of it; and rubbing the paper between my hands, though there was thereby produced a conſiderable heat, yet it did not reach to what I deſired; but continuing a little while to rub the paper, it on a ſudden took fire, and blazed out, ſo that it would have burned my hand, had it not been guarded by a thin glove, which was thereby ſcorched, and in part ſhrivel'd up. After the ſame manner, to make the experiment the more certain, I fired another piece of paper.

45. To try, whether our phoſphorus, which appeared not inferior to that of Mr. *Krafft*'s, would (as his ſometimes did) fire gun-powder; we took a little of our ſhining matter, and having wiped it dry, we put it upon ſome dry gun-powder, and with a knife preſſed it, and in ſome ſort rubbed it upon the black grains; but found, that though a heat were produced, and ſometimes ſuch as would make ſome of the corns of powder have a bluiſh flame, yet the mixture would not go off: ſo that the aſſiſtant, to whom I left the care of repeating the experiment, preſuming it would not ſucceed, ſcrupled not to hold his head over it, that he might the better ſee what change was made in the mixture; but then, upon a ſudden, the powder took fire, and the flame ſhooting up, burnt his hair.

46. The ſame perſon, not long after, bringing me ſome newly diſtill'd grains of our noctiluca, covered with ſome of the ſhining water, that came over with it, he unluckily broke the glaſs in his pocket; whereupon the heat of his body, increaſed by the motion which a long walk had put it into, ſo excited the matter, fallen out of the broken vial, that it burned two or three great holes in his cloaths.

47. And having put together about half a grain of our dry noctilucal matter, and ſix times its weight of common flowers of ſulphur, they were lodged in the fold of a piece of white paper, which was laid upon a board; and when I had a little bruis'd and rubbed this with the haft of a knife, it ſhone through the intercepted paper very vividly, but did no more. Wherefore, ſuſpecting that the want of air was the reaſon why it did not burn, I opened the paper, and found, that as ſoon as the air had acceſs, it took fire, and furiouſly burned the paper; and, if I had not been wary, wou'd have burned me too. At another time, in making the ſame experiment, the ingredients being well rubb'd together in folded paper, though before the paper was diſplaved and expoſed to the air, they did not kindle; yet upon contact with the air, the mixture took fire, and flaſhed away

at once, with a great blaze, like fired gun-powder; only the flame appeared more luminous.

48. The higheſt effect of the heat of our icy noctiluca, was caſually produced by my aſſiſtant; who, being deſirous to try, whether ſome that was newly prepared, were good, began to draw letters with it, upon a piece of plank, that had been long uſed in the laboratory, as part of a ſtove; and, chancing to preſs the matter hard upon this board, that the conſtant heat of the place had brought to an unuſual degree of dryneſs, he found, to his ſurprize, that he had not only ſhining, but burning letters; the lucid matter having actually ſet on fire thoſe parts of the wood, againſt which he had ſtrongly preſſed it.

Whether the ſolid noctiluca be an alkali, or an acid, examined.

49. To examine, particularly, what family, or ſort of ſalts, the ſaline part of our noctilucal matter either belong'd, or had moſt relation to, I ſuffered a little of it to reſolve *per deliquium* into a clear liquor, and then made therewith ſome of the tryals, by which I uſually examine what ſpecies a ſalt belongs to. And gueſſing this liquor by the taſt, and the manner wherein it was made, to be ſomewhat, tho' not altogether, of the nature of ſpirit of ſea-ſalt; I dropt a little of it upon a convenient proportion of ſyrup of violets, and found that it turned it not green, but of a fine carnation colour. I found alſo, that a very little of our liquor, preſently deſtroy'd the blue colour, and not the other of a tincture of *Lignum nephriticum*.

50. I, likewiſe, put ſome of this liquor of the noctiluca, upon filings of copper; which, being thoroughly drench'd, and ſome of them cover'd with it, I expoſed them in a hollow glaſs for two or three days to the air: and by this means had, without the help of heat, a ſolution of ſome of the filings, the colour of which ſeemed to partake of green and blue.

51. To make the ſaline nature of this liquor the more manifeſt, I put ſome of it upon powder of red coral, which it preſently corroded with noiſe and froth; and putting another parcel of the ſame liquor, upon ſome dry ſalt of tartar, there immediately enſued a fierce conflict between them, whereby ſome noiſe and much froth was produced; ſo that I thought it needleſs to waſte any more of the noctilucal matter, to make it farther apparent, that our liquor was not, as moſt chymiſts would have expected, of an urinous nature, but belong'd to the family of acid ſalts; and ſeemed to be near of kin to that branch of them, to which the ſpirituous part of common or ſea-ſalt belongs.

Phenomena of this phoſphorus in glaſſes hermetically ſealed.

52. I put ſome of our dry phoſphorus into a clear vial, able to hold about an ounce of water; and having very carefully cloſed this glaſs, I laid it aſide, and obſerved it to continue to ſhine for ſome few days; after which the light manifeſtly decayed, and ſoon after quite diſappeared; tho' I thought it poſſible, that it did not expire ſo ſoon as it ceaſed to be viſible; becauſe the whitiſh fumes, emitted by the matter, whilſt it continued to ſhine, had covered the inſide of the

glaſs, with a kind of whitiſh ſoot, that, at length, darkening it, might well hinder a faint light from pervading the veſſel, and reaching the eye. But it ſeems, that the air included with the phoſphorus, either had ſome vital ſubſtance (if I may ſo call it) prey'd upon thereby, or elſe was by the fumes of the phoſphorus, to name no other poſſible ways, tamed, and rendred at length unfit to continue the particular flame of our noctiluca.

53. Yet to purſue the deſign of making a light more laſting than ordinary, by keeping the matter from the external air; I took ſome of our noctilucal matter, that came over with the aqueous, from which 'twas not ſo eaſily ſeparable, but that I thought it beſt to leave them together, (in regard that it ſhone ſo well, that it might paſs for an excellent portion of the aerial noctiluca;) and this we ſealed up in a glaſs-egg (whoſe bottom had been made flat) and ſetting it in a place, where it would be frequently in my eye, I obſerved it from time to time, eſpecially at night, and found it continue to ſhine for a week, or longer; and this with ſo little decay of light, that I was ſurprized, when, coming in the night-time to look upon it, I found it to ſhine no more; eſpecially ſince I could not reſtore any manifeſt light to it, either by agitation, or by moderately warming the ſealed glaſs, that contained it.

54. After many obſervations made of the degrees of light, that our icy noctiluca afforded, as 'twere of its own accord, without external heat; I thought fit to try, whether, by the application of a moderate heat of the fire, the light might not be much invigorated, and perhaps the phoſphorus it ſelf be brought actually to kindle, even in a cloſe veſſel. We took, therefore, ſome grains of our conſiſtent phoſphorus, and put them into a round glaſs-egg, ſomewhat larger than an ordinary hen-egg, fitted with a ſtem of a proportionable bigneſs, and about two thirds of a foot long. This being hermetically ſealed up, the round part of it was warily, and, by degrees, warmed at the fire; and then we inſtantly removed it into a dark place, where the included matter, not only ſhone much more vividly than before it was heated, but ſome portions of it were brought to an actual flame; as appeared both by the radiant ſplendor of the burning matter, and by the condition of the ſmoke it emitted; and yet more manifeſtly, by the intenſe heat which the flaming part of the matter, communicated to that part of the glaſs whereto it adhered; for there, the veſſel was not to be ſo much as touched without inconvenience: and when this flame expired, which it did after no long time, the portion of the matter, lately kindled, no more ſhone or burnt as before; but was reduced to the condition of the reſt of the noctilucal matter, together with which it, for a while, retained a conſiderable degree of light, upon account of the heat it had been expos'd to, over and above that luminouſneſs which ordinarily belonged to it.

This experiment appeared ſo ſtrange, and was ſo delightful, that, to gratify the curious, and purſue my own deſign, 'twas repeated within the compaſs of a month or two, between twenty and thirty times; the ſame matter being ſtill kept in the ſame veſſel: tho', by being melted, and in great part ſublimed by its frequent approaches to the fire, it was divided into ſeveral parcels. But that made the experiment ſo much the more pleaſant, in regard that ſometimes more than one, or, perhaps, than two portions of the matter would ſeem to burn at once. This was looked upon as a very new and ſcarce credible thing, that a perſon ſhould be able to bring a body to burn with an actual flame, and for no inconſiderable time, in a glaſs hermetically ſealed, and not large neither. But after we had made many trials, in the above mentioned glaſs, there happened a phenomenon, which gave me ſome ſuſpicion, that it was not then actually ſealed; tho' it did not appear, but that it had been very well ſealed at firſt, and might continue ſo during ſeveral tryals: for after this ſuſpicion, we uſed the glaſs ten or twelve times, or, perhaps, oftener, to make the recited experiment; and after all thoſe, we could perceive no crack or flaw in the ball or ſtem of the glaſs; and found it difficult to get in the point of a ſmall pin into a little hole, which we either found, or, by endeavouring to find, made at the apex. However, by the things formerly related, it appeared, that our noctilucal matter would burn with leſs vent, by great odds, than other fewel known to us; and that a ſmall quantity may be made to burn and ſhine longer than one would expect. And we were encouraged by what we ſaw, to hope, that if a more conſiderable quantity of matter were put into a conveniently ſhaped glaſs, and aſſiſted with other friendly circumſtances, eſpecially if the luminouſneſs could be a little heightened, it might be rendred uſeful in ſhips, and magazines of powder.

I muſt not omit, that ſometimes there appeared a little liquor in this glaſs, and that the reſt of the matter, by the repeated operations of the fire, was turned to a red colour, which it yet retains.

In water.

55. I put two grains of our icy noctiluca into a ſmall glaſs-egg, and pour'd a pretty quantity of water on it: we heated the liquor well, yet without making it boil, and thereby melted the little fragments of ſolid matter, and made them flow into one liquid maſs, that kept it ſelf at the bottom, diſtinct from the water. This done, we preſently removed the glaſs into a dark place, and pouring out the water, we obſerv'd, that as ſoon as the air came to touch the noctilucal matter, it ſeemed to be kindled into an actual flame, that afforded a very vivid light; which ſhews, that a kind of fire may be kept under water, as long as one pleaſes, without ſenſibly burning; and yet in a moment, upon the bare removal of the water, manifeſt it ſelf in the form of actual fire. That our ſhining ſubſtance was of this nature appeared evident, becauſe the water, being poured out ſomewhat too haſtily, carried along with it, which I did not intend it ſhould, the whole maſs of the noctilucal

lucal matter; and this, by its fall into the ſilver cup, employed to receive the liquor, was divided into two or three parts, which coming to a fuller contact with the air, blazed out much more than when they were in the glaſs, and afforded us a delightful ſpectacle; for the flame burned upon the water with much light and fierceneſs, and a ſtrange deal of ſmoke; between whiles ſputtering with a noiſe, like that of ſalt-petre made to burn upon a live coal. Theſe flames continued upon the water for a pretty while; and after their extinction, looking into the ſilver cup, we found ſeveral flakes of a reddiſh matter, that lay at the bottom of the water; and the ſide of the ſilver cup, that was next to the liquor, looked almoſt as if fine brick-duſt had been ſtrewed upon it.

In a glaſs of a particular colour.

56. We took two or three grains of our matter, and put it into a vial, of an almoſt ſpherical figure, capable of holding about twelve ounces of water: this vial was made of fine glaſs, of a very pleaſant colour, participating of thoſe called orange and aurora; but the lucid matter being ſhut up in it, and carried into a dark room, did not appear through the glaſs to be conſiderably altered in colour. And becauſe I imputed this partly to the ſmalneſs of the fragment of the phoſphorus, with regard to the capacity of the veſſel, through which it would give no more than a faint light; I cauſed the glaſs to be conſiderably heated, and then brought it into a dark room; where, as ſoon as 'twas come, the included matter ſeemed to be actually flaming, and the trajected rays appeared of an unuſual and glorious colour; the light being ſo conſiderable, that it made ſeveral bodies diſtinctly viſible, at a conſiderable diſtance from the glaſs: and we judged that by the help of it a book of a good print might have been eaſily read. But this light, which was the greateſt we had, till then, produced with our phoſphorus, did not laſt long in its vigour; gradually decaying, till, in a ſhort time, it came to little more than the uſual ſplendor of the noctilucal matter.

In oil of mace.

57. The little vial, wherein the noctilucal matter and ſome oil of mace were included, having been ſet aſide as uſeleſs, I afterwards chanced to caſt my eye on it; and to try, whether the unſucceſsful experiment I had made before, was not of the contingent kind; there being a dark corner in the room, I carried the vial thither; and although it were yet broad day, I was ſomewhat ſurprized, upon unſtopping it, to find the included matter immediately afford a vigorous light; which put me afterwards upon repeating the experiment at different times, which I did with the like ſucceſs, without being able to determine the cauſe of this odd phenomenon.

Actual fire and flame produced in the ſolid noctiluca.

58. We kept in a ſmall receiver, a parcel of conſiſtent noctiluca, in which my aſſiſtant told me, he had met with a ſtrange phenomenon, that ſeemed to appear by chance. This receiver I took into my cuſtody, and pouring out the common water, with which the ſplendid matter was kept covered, to hinder it from ſteaming away,

we obſerved no other change, than that, upon the removal of the water, and the contact of the air, the noctiluca would immediately ſhine, and continue to do ſo, till we thought fit to extinguiſh it, by pouring water on it again.

This being done in the morning, I conſidered on the following night, that the receiver having been kept in the laboratory, which being a very warm place, 'twas but fit, in order to make the trial a fair one, to bring the ſhining matter to as great a warmth, as it had in the laboratory, where it exhibited the phenomenon I was deſirous to ſee. Having, then, cauſed the receiver, with the water in it, to be held in a hot place, till the liquor had attained a fit degree of warmth, we poured out the water; and within a minute or two after, had the pleaſure to ſee, that the conſiſtent matter, notwithſtanding the wetneſs that, in probability, the water had left on it, did, upon contact with the air, take fire of it ſelf, not without noiſe, and burn with a manifeſt and actual flame. But before we could pour in water to quench the fire, the violence of the flame had broke the receiver, which was thick; and thrown off a piece above half as broad as the palm of one's hand; by which unlucky accident we were hindred from endeavouring to try, whether we could, by repeated experiments, diſcover the cauſe of the appearing contingency of this odd phenomenon.

The way of preparing the aerial noctiluca.

At length we come to give the method of preparing our noctiluca.

But, 1. I will not poſitively affirm, that the matter I employed is the very ſame that was made uſe of by the ingenious *German* chymiſts in their noctiluca; for ſome inquiſitive men have told me, that the *Germans* mix two or more diſtillable materials; whereas I employed but one ſubſtance capable of diſtillation. 2. Tho' the foregoing obſervations were commonly made upon that ſubſtance, which, I gueſs, to be, at leaſt, the chief employed by the *Germans*; yet I firſt thought, and upon my firſt trial found, that 'tis poſſible to make a noctiluca of a dry and pulverable ſubſtance, which, for ought I can gueſs, was never employed by Mr. *Krafft*, or thoſe from whom he had his ſecret. And beſides this ſecond ſort of phoſphorus, we made a third, which was obtained from a material, that never had been either a part, or an excrement of a human body; nor was mixed with any thing that had been ſo. 3. To name the matter, tho' ever ſo explicitly, wou'd not, in my opinion, have ſufficed to inform thoſe who wou'd work upon it; for chymiſts themſelves would, in all probability, work, as hitherto, on other occaſions, they have done, upon the volatile and ſaline, which they preſume to be the only ſpirituous and noble parts of the concrete; throwing away the reſt as uſeleſs and abominable. 4. I think fit to give notice, that having employed the material of our noctiluca, without previous fermentation or putrefaction, tho' it was proceeded with after the ſame manner, with that whereby we obtained our ſhining ſubſtance; and tho' it afforded a ſubſtance, for colour and conſiſtence not unlike our luciferous matter; yet I could not find that it would ſhine at all. And, indeed, there are ſo many circumſtances that may make the experiment miſcarry, that he who ſhall, at the firſt attempt, ſucceed in preparing this liquor, muſt be a very skilful, or a very lucky operator. Laſtly, that it may appear, as well by the very different preparations, as by the different phenomena of the *Phoſphorus hermeticus*, and of the aerial noctiluca, that there is a great diſparity between thoſe lucid bodies; I ſhall here add the way we employed to make either the *Phoſphorus Balduini*, or ſome other like it, as it was practiſed in my furnaces. A diſſolution being made of fine white chalk in good ſpirit of nitre, or clean *Aqua fortis*, it is to be filtred thro' cap-paper; and the clear ſolution to be evaporated, till there remains a dry ſubſtance; with this white calx you are to overlay the inſide of ſome veſſel, made of good earth, that will endure the fire, and of a round figure, which is more convenient than that of ordinary crucibles; and to the matter contained in this veſſel, you are to give, for about half an hour, or an hour, according to the largeneſs of it, and other circumſtances, a due degree of fire, which 'tis not eaſy to hit, and which ordinarily requires a conveniently ſhaped veſſel, whereby the flame or heat may be reverberated, till you perceive the matter to have acquired a diſpoſition to retain the light; and then the earthen veſſel, which uſually ought to be ſomewhat ſhallow, and not to exceed many inches in diameter, is to have a cover of fine glaſs or cryſtal, carefully cemented on it, to preſerve it from its great enemy, the air.

And the PHOSPHORUS BALDUINI.

The proceſs for preparing the aerial noctiluca.

We took a large quantity of human urine, that had been for a competent time digeſted or putrefied. This we diſtilled with a moderate heat, till the ſpirituous parts were drawn off; after which, the ſuperfluous moiſture alſo was evaporated, till the remaining ſubſtance became of the conſiſtence of a thick ſyrup, or a thin extract; and this being well incorporated with about thrice its weight of fine white ſand, the mixture was put into a ſtrong retort; whereto we joined a large receiver, in great part filled with water. Then, the two veſſels being carefully luted together, a naked fire was gradually adminiſter'd for five or ſix hours; that all, which was either phlegmatic, or otherwiſe volatile, might come over firſt. When this was done, the fire was increaſed; and at length, for five or ſix hours, made as ſtrong and intenſe, as the furnace, a good one, was capable of giving. By this means there came over plenty of white fumes, almoſt like thoſe that appear in the diſtillation of oil of vitriol; and when theſe fumes were paſt, and the receiver grew clear, they were after a while ſucceeded by another ſort, which ſeemed in the receiver to give a faint, bluiſh light, almoſt like that of little, burning matches dipped in ſulphur. And laſt of all, the fire being very vehement, there paſſed over another ſubſtance, that was judged more ponderous than the former, becauſe much of it fell thro' the water to the bottom of the receiver; whence being taken, it appeared, by ſeveral effects, and other phenomena, to be of a lucid nature*.

Experiments about exploſions,

I ſhall here, for the relation of the ſubject, add a few experiments, made to ſhew the nature of exploſions.

With the ſpirits of nitre, and of wine.

Having put one ounce of ſpirit of nitre, ſo ſtrong, that its fumes made the upper part of the containing glaſs always reddiſh, into a bolt-head, with a long neck, able to contain twelve or ſixteen times as much; we cauſed an equal weight of highly rectified ſpirit of wine to be taken; and a little of it being put to the ſpirit of nitre, it preſently made ſo ſtrong and quick an exploſion, that ſome of it flew out of the glaſs, and hit againſt the cieling of the room; and falling upon the face of him who held the glaſs, made him think fire had fallen thereon; but ordering him to proceed more warily, he put into the bolt-head only part of a ſpoonful of ſpirit of wine at a time; yet at many of theſe affuſions, there would be a great noiſe, as of an ebullition produced, tho' no quantity of froth; and this was accompanied with ſo great a heat, that I could not hold the glaſs in my hand; when immediately there would iſſue out a large red ſmoke, to which, when I caus'd a lighted candle to be held, tho' at half a foot diſtance from the top of the bolt-head, it would preſently take fire, and burn at the top of the glaſs, like a flame at the upper end of a candle; till I caus'd it to be blown out, that freſh ſpirit of wine might be poured in; which being all mixed with the other liquor, the heat and conflict ceaſed. To ſhew that the noiſe and ebullition produced in this mixture, is not unattended with a brisk, expanſive, or exploſive motion, we put an ounce of the ſtrong ſpirit of nitre above-mentioned, into a moderately large bolt-head, furniſhed with a proportionable ſtem, over the orifice, whereof we ſtrongly tied by the neck a thin bladder, out of which moſt part of the air had been ſqueez'd, and into which we had conveyed a ſmall vial, containing a little highly rectified ſpirit of wine. Then this vial, that before was cloſed with a cork, being unſtopp'd, without untying or taking off the bladder; a ſmall quantity, by gueſs not a quarter of a ſpoonful, of the ſpirit of wine, was made to run down into the ſpirit of nitre; where it preſently produced a great heat and commotion, and blew up the bladder as far as it would well ſtretch; filling alſo the ſtem and cavity of the glaſs with very red fumes; which preſently after forced their way into the open air, in which they long continued to aſcend in the form of an orange-coloured ſmoke.

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* Dr. *Wall* tells us, that Mr. *Boyle* finding, that urine yielded but a very ſmall quantity of phoſphorus, importuned him to look out for ſome other ſubject, that might afford it in greater plenty; upon which he cauſed, in the ſummer-time, a piece of dry matter to be dug up in the fields, where nightmen emptied their veſſels; and breaking it in the dark, a great number of ſmall particles of phoſphorus appeared therein. This matter the Dr. immediately carried to Mr. *Boyle*, and Mr. *Bilgar*, the chymiſt, went preſently to work up by Mr. *Boyle*'s direction; but could make very little or no phoſphorus from it, till another material was added thereto in diſtillation: and then he made it in ſuch plenty, that ſelling large quantities at ſix guinea's, or ſix *Louis d'Or's*, the ounce; he ſoon became rich, and left *England*. *Philoſ. Tranſ.* N°. 314. p. 69.

'Tis very remarkable, what pains and coſt the judicious M. *Homberg*, beſtowed upon human excrement, in order to diſtil from it a fine, clear, limpid oil, without any ill ſcent; by means whereof, he hoped to fix common mercury into pure ſilver. After many laborious proceſſes, he, at length, obtained ſuch an oil; but it failed in fixing the mercury. This, however, lead him to diſcover an excellent phoſphorus, which yields its light without any friction, application of heat, or mixture with any other body; and that as well by night, as by day. This phoſphorus is a powder made from equal parts of human dung, and roch alum, mixed together, dry'd and prepared by a particular proceſs, which the author deſcribes at large. The colour of it is black, brown, red, green, yellow, or white, according to the veſſel, and the degree of fire uſed in the preparation. It begins to flame as ſoon as ever it is expoſed to the air, and ſets fire to any combuſtible matter whereon 'tis laid; and muſt, therefore, be kept in the ſame glaſs wherein 'tis made; for to put it out of one veſſel into another, or return any parcel of it back into the ſame, wou'd ſet it all on fire. See the *French Memoirs*, A. 1711. p. 49—59. and 307—316.

The ſame author prepared three ſorts of phoſphorus; one that would ſet combuſtible materials on fire, without appearing it ſelf in flame; another, which gives fire and flame like a burning coal; and a third, which would burn and flame like a lighted taper; and theſe only differ'd according to the degree of fire, and the quantity of alum employed in their reſpective preparations. The ſun's rays, or the moiſture of the air, gradually admitted into this powder, would ſpoil it; and it muſt, therefore, be kept in a dry, dark place. M. *Lemery* having ſucceſſively ſubſtituted ſeveral materials for the human dung, employed in this preparation, found, that almoſt any animal, or vegetable material, would ſerve in its ſtead; as the yolks of eggs, wheat-flower, *&c.* with different proportions of alum. See *Memoir. de l'Acad.* A. 1714. p. 520.

With the oils of vitriol and of turpentine.

I have more than once taken ſtrong oil of vitriol, and common oil of turpentine, and warily mixed them in a certain proportion, by ſhaking them very well together; whereupon has enſued ſo furious an agitation of the minute parts of the mixture, and ſo vehement, or ſudden an expanſion, or exploſion, as did not only ſeem ſtrange to the ſpectators, but would have proved dangerous too, if I had not taken care before hand, that the trials ſhould be made in a place, where there was room enough; and that even the operator, who ſhook the veſſel, ſhould ſtand at a convenient diſtance from it.

With two bodies actually cold, ſal-armoniac and oil of vitriol.

We put two ounces of powder'd ſal-armoniac into a large glaſs tube, hermetically ſealed at one end, and into the ſame, a ſlender glaſs pipe, furniſhed with two ounces of oil of vitriol, which was ſo placed, that at pleaſure we could make the liquor run out into the larger tube, which was cloſ'd exactly, ſo that nothing might get in or out. My deſign was, that this inſtrument ſhould be ſo warily inverted, that the operator might get out of the way, and the oil of vitriol falling ſlowly upon the ſal-armoniac, ſhou'd, without cauſing any heat, produce an exploſion not dangerous to the by-ſtanders. But in my abſence the operator, not ſtaying for particular directions, raſhly inverted the inſtrument, without taking care to get away; whence it happened, that as ſoon as ever the contain'd liquor, being too plentifully poured out, came to work on the ſal-armoniac, wherewith it uſually produces cold, there enſued an expanſion or exploſion, ſo ſurprizingly great, that with a vehement noiſe the glaſſes were broken into a multitude of pieces, and much of the mixture thrown up, with violence, againſt the operator, whereby his hat was ſtruck off, and his face, eſpecially about his eyes, much hurt; whence, immediately, tumors, extremely painful, were produc'd; which might, alſo, have been very dangerous, had I not directly cauſed the parts affected, to be bath'd with a ſolution of *Saccharum Saturni* in fair water; by which means, within an hour or two, the pain that had been ſo raging, was taken away, and the fretting oil kept from ſo much as breaking the skin of the tumors that it had rais'd. At another time we made a like tryal in a ſafer way, by tying a bladder ſo to the top of a bolt-head, into which we had, beforehand, put the ſal-armoniac, that by warily moving the bladder, whence the air had been preſſed, we cou'd make ſome of the ſal-armoniac, we had lodged in its folds, to fall upon the liquor, with which it preſently made an exploſive mixture that quickly blew up the bladder *.

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* It may appear ſurprizing, that two cold liquors being put together ſhould immediately flame, or ſet fire to gunpowder; yet any acid ſpirit highly rectified, being mix'd with the eſſential oil of an aromatic plant, well freed from acid, and thereby render'd partly ſulphureous, will do this. But, as M. *Homberg* obſerves, the oils of *European* plants will not ſerve for the experiment, but it requires thoſe of hotter climates, *viz.* oil of cinnamon, cloves, mace, *&c.* Nay, if even theſe be adulterated with the other, or any way ſophiſticated, 'twill fruſtrate the tryal; which may, therefore, prove a criterion, whereby to examine them. *Memoir. de l'Acad. A.* 1701. *p.* 1724.

Dr. *Slare* furniſhes us with many curious experiments relating to this ſubject. See *Philoſ. Collect.* N° 3. *p.* 48. *Philoſ. Tranſ.* N° 150. *p.* 291. N° 213. *p.* 200.

But let us hear Sir *Iſaac Newton* upon this ſubject. " When oil of vitriol, (ſays he) is drawn off from its weight of nitre, and from both ingredients, a compound ſpirit of nitre is diſtill'd, and two parts of this ſpirit are poured upon one part of oil of cloves, or caraway-ſeeds, or of any ponderous oil of vegetable or animal ſubſtances, or oil of turpentine, thickened with a little balſam of ſulphur, and the liquors grow ſo very hot in mixing, as preſently to ſend up a burning flame; does not this very great and ſudden heat argue, that the two liquors mix with violence, and that their parts in mixing, run towards one another with an accelerated motion, and claſh with the greateſt force? And is it not for the ſame reaſon, that well rectified ſpirit of wine, poured on the ſame compound ſpirit, flaſhes; and that the *Pulvis fulminans*, compoſed of ſulphur, nitre, and ſalt of tartar, goes off with a more ſudden and violent exploſion than gun-powder; the acid ſpirits of the ſulphur and nitre ruſhing towards one another, and towards the ſalt of tartar, with ſo great a violence, as by the ſhock to turn the whole, at once, into vapour and flame? ———— When a dram of the compound ſpirit of nitre

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“ was poured upon half a dram of oil of caraway ſeeds *in vacuo*, the mixture immediately made a flaſh like gun-powder, and burſt the exhauſted receiver, a glaſs ſix inches wide and eight deep; and even the groſs body of ſulphur powder'd, and with an equal weight of iron filings and a little water, made into paſte, acts upon the iron, and in five or ſix hours grows too hot to be touched, and emits a flame. And by theſe experiments, compared with the great quantity of ſulphur with which the earth abounds, and the warmth of the interior parts of the earth, and hot ſprings, and burning mountains, and with damps, mineral coruſcations, earth-quakes, hot ſuffocating exhalations, hurricanes, and ſpouts; we may learn, that ſulphureous ſteams abound in the bowels of the earth, and ferment with minerals, and ſometimes take fire with a ſudden coruſcation and exploſion; and if pent up in ſubterraneous caverns, burſt the caverns with a great ſhaking of the earth, as in ſpringing of a mine. And then the vapour generated by the exploſion, expiring thro' the pores of the earth, feels hot, and ſuffocates, and makes tempeſts and hurricanes, and ſometimes cauſes the land to ſlide, or the ſea to boil, and carries up the water thereof in drops, which, by their weight, fall down again in ſpouts. Alſo ſome ſulphureous ſteams, at all times when the earth is dry, aſcending into the air, ferment there with nitrous acids, and ſometimes taking fire, cauſe lightning, and thunder, and fiery meteors. For the air abounds with acid vapours, fit to pomote fermentations, as appears by the ruſting of iron and copper in it, the kindling of fire by blowing, and the beating of the heart by means of reſpiration. Now the above mentioned motions are ſo great and violent, as to ſhew, that in fermentations the particles of bodies, which almoſt reſt, are put into new motions by a very potent principle, which acts upon them only when they approach one another, and cauſes them to meet and claſh with great violence, and grow hot with the motion, and daſh one another into pieces, and vaniſh into air, and vapour, and flame.” *Newton. Optic. p.* 353—355.

EXPERIMENTS
AND
OBSERVATIONS
UPON THE
SALTNESS of the SEA.

THE cauſe of the ſaltneſs of the ſea appears, by *Ariſtotle*'s writings, to have exerciſed the curioſity of naturaliſts before his time; ſince which, his authority has, for many ages, ſway'd the generality into his opinion; till of late, ſome learned men took the boldneſs to queſtion the common doctrine: and from that time, the controverſie has been kept on foot, and, for ought I know, will be ſo, as long as 'tis argued, on both ſides, but by dialectical arguments. I ſhall here, therefore, deliver ſome particulars about the ſaltneſs of the ſea, obtained by my own tryals, where I was able to make them; and where I was not, from the beſt relations I could procure.

The ſaltneſs of the ſea, whence?

Firſt then, *Ariſtotle* and his followers, derive the ſaltneſs of the ſea from the aduſtion of the water by the ſun-beams; but it has not, I believe, been found, where no ſalt or ſaline body was diſſolved in, or extracted by water, expoſed to the ſun, or other heat, that any ſuch ſaltneſs is produced. There are many lakes and ponds of freſh water to be met with, even in hot countries, where they lie expoſed to the action of the ſun. And as for other heat, by diſtilling off common water in large glaſs bodies, till all the liquor came over, I found, at the bottom, not above a three thouſandth part of ſalt, among a little white earthy ſubſtance. And tho' there had been a greater quantity of ſalt, which, perhaps, may be met with in ſome waters, I ſhould not have concluded it generated out of the water by the action of the fire; becauſe I have, by ſeveral tryals, found, that in many places, common water, before ever it is expoſed to the heat of the ſun, or other fire, has in it a ſaltneſs, eaſily diſcoverable, of the nature of common or ſea-ſalt.

Whether the ſea be ſalter at the top than at the bottom?

But ſome champions for *Ariſtotle*'s opinion alledge experience for it; vouching the teſtimony of *Scaliger* to prove, that the ſea taſts ſalter at the top, than at the bottom; where the water is affirmed to be freſh.

'Tis true indeed, having often obſerved ſea-ſalt diſſolved in water, uſually to begin its concretion, upon the abſence of the ſuperfluous liquor, I think it not impoſſible, that, ſometimes, in very hot climates, the ſea may taſt more ſalt at the ſurface, than at ſome diſtance beneath it. But conſidering with how great a proportion of the ſalt common water is impregnated, before it ſuffers ſaline concretions to begin; and how far ſhort of that proportion, the ſalt contained in the ſea water is, being found about *Holland*, ſcarcely as one to forty; it ſeems not likely, that *Scaliger*'s obſervation was well made; and it muſt be very unlikely that it ſhould generally hold, if the ſaltneſs of the ſuperficial parts of the ſea, be compared with that of the lower.

Yet I do not build my opinion wholly upon this argument, that ſalt being a heavier body than water, muſt neceſſarily communicate moſt ſaltneſs to the loweſt parts.

For though this be plauſible, yet water is a fluid, the reſtleſs agitation of whoſe corpuſcles, makes them, and the particles they carry with them, perpetually ſhift places; whereby the ſame parts come to be ſometimes at the top, and ſometimes at the bottom. This, therefore, being conſidered, with the peculiar diſpoſition of diſſolved ſea-ſalt, to begin its coagulation upon the ſurface of the water, it may render the argument ſuſpected; and the rather, becauſe that in metalline and other tinged ſolutions, I have not uſually obſerved the upper part of the liquor to be manifeſtly deeper coloured than the lower; though between metalline bodies and their menſtrua, the diſproportion of ſpecific gravity uſually far exceeds that which I have met with, between ſea-ſalt and common water.

'Tis urg'd out of *Linſchoten*, that wanting freſh water near *Goa*, they make their ſlaves fetch it from the bottom of the ſea. But were this ſtrictly true, it wou'd not univerſally follow, that all the water at the bottom of the ſea is freſh; ſince in other parts the contrary has been found by experience. Springs of freſh water may happen in ſome parts of the ſurface of the earth, covered with the ſea, as they do in innumerable vallies, and other places of the terreſtrial ſurface: not to mention thoſe ſprings that often appear upon a low ebb of the ſea. The curious *Hungarian* governor, who gives us an account of the wonderful waters in his country, relates, that in the river *Vagus*, which runs by the fortreſs *Galgotium*, the veins of hot water ſpring up at the bottom of it. And I have been aſſured by more than one learned eye-witneſs, that there is a place upon the

Neapolitan coaſt, where they obſerved the water to ſpring up hot beneath the ſurface of the ſea; ſo that one of them thruſting in his hand and arm ſomewhat deeper, found an offenſive degree of heat therein.

But as to the particular caſe of *Goa*, I inquired of a great traveller, and a man of letters, who having lived in that city, and the neighbouring places, gave me a pertinent account of it. He tells me, that the divers do not now think it needful, to fetch their freſh water ſo low as from the bottom of the ſea; and that by the little depth, whence he caus'd it to be taken up, he judg'd it did not come ſo much from any freſh water ſprings, riſing at the bottom of the ſea, as from a ſmall river, which, not far from thence, runs into the ſea; with ſuch a conjuncture of circumſtances, that the freſh water yet keeps it ſelf tolerably diſtinct and potable, though not very good.

I might alſo pretend to a clear experimental demonſtration of the contrary to what *Scaliger* delivers, from the teſtimony of the learned *Patricius*; who affirms, that being upon the ſea near *Candia*, he did, in the company of a *Venetian* magiſtrate, *Moccenigo*, let down a veſſel to the bottom of the ſea, where, by the help of a contrivance, it was unſtopp'd, and filled with water; which being drawn up, was found to be not freſh, but ſalt. However, I ſhall confirm the ſaltneſs of the ſea at the bottom, by ſome leſs exceptionable obſervations.

The firſt is, that of the perſon who, by the help of an engine, cou'd ſtay a conſiderable time at the bottom of the ſea; of whom I learn'd, that the water had as ſalt a taſt there as at the top.

The next obſervation I obtained by means of a great traveller into the *Eaſt* and *Weſt-Indies*, who having ſeen the famous pearl-fiſhing at *Manar*, near the great cape of *Comori*, was aſſured by the divers, that the ocean there was ſalt at the bottom. And the ſame perſon being asked about the ſaltneſs of the ſea, in a certain place under the torrid zone; which, by the relation of a traveller, I was inclin'd to think, abounded extraordinarily with ſalt; he affirmed, that not only the divers declared to him, that the ſea was there exceeding ſalt at the bottom, but brought up ſeveral hard lumps of ſalt from thence; whereof the fiſhermen and others made uſe to ſeaſon their meat, as himſelf alſo did; which yet we may aſcribe not only to the plenty of ſalt already diſſolved in the water, but to the greater indiſpoſition that ſome ſorts of ſalts have, to be diſſolved in that liquor. And laſtly, meeting with an inquiſitive engineer, who had many opportunities to make obſervations in deep waters; I deſired him to take a certain copper veſſel of mine, furniſhed with two valves opening upwards, and let it down at ſea; but he told me, I might ſave my ſelf the trouble, for that with a tin veſſel, very little differing from mine, he had, near the ſtreights of *Gibraltar*, fetch'd up ſea-water from the depth of about forty fathoms, and found it to be as ſalt in taſt, as the water near the ſurface.

Theſe obſervations may ſuffice to ſhew, that the ſea is ſalt at the bottom, in thoſe places where they were made; yet I thought it was not fit to acquieſce in them, but rather endeavour to ſatisfie my ſelf, by the beſt trial I could procure to be made with my copper veſſel, what ſaltneſs is to be found in the water at the bottom of our ſeas, when examined by weight, and not by taſt; and in order thereto, having delivered the above-mentioned inſtrument to the engineer, when he was going to ſea; he ſent me, together with it, two bottles of ſea-water, taken up, the one at the top, and the other at the bottom, fifteen fathoms deep. The colour and ſmell of theſe two waters were ſomewhat different; but when I examined them hydroſtatically, by weighing a roll of brimſtone firſt in one, and then in the other, I ſcarce found any ſenſible difference in their ſpecific gravities. So that if the degree of the ſaltneſs of ſea-water, may be ſafely determined by its greater or leſſer weight; then, ſo far as this ſingle experiment reaches, the ſaltneſs is equal at the top and bottom of the ſea.

That ſprings of freſh water may riſe at the bottom of the ſea.

And as to thoſe very few places, if really there have been any, where the ſea-water was found freſh at the very bottom; I think one may aſcribe the taſt of the water, to the bubbling up of ſprings of freſh water, at, or near enough to, thoſe very places. I know this has the appearance of a paradox; ſince it may ſeem altogether unlikely, that ſo ſmall a ſtream of water as can be afforded by a ſpring, ſhould be able to force its way up, againſt the reſiſtance of ſo vaſt a weight, as that of the incumbent ſea; eſpecially ſince this liquor, by reaſon of its ſaltneſs, is heavier *in ſpecie* than freſh water.

But perſons acquainted with hydroſtatics, know, it matters not how great a quantity of liquor, lies laterally higher than the lower orifice of the pipe or channel, that gives paſſage to the fluid to be impell'd up into it; provided the upper ſurface of that in the channel or pipe, have a ſufficient perpendicular height, with regard to that of the ſtagnant water; for no more of all this fluid will hinder its aſcent, than the weight of ſuch a pillar of it, as is directly incumbent thereon. So that, conſidering the channel wherein a ſpring runs into the ſea, as a long inverted ſyphon; if that part either of the neighbouring, or more diſtant ſhore, whence the ſpring or river takes its courſe, be a hill, or a rock, or any other place conſiderably higher than that part of the bottom of the ſea, at which the channel, which conveys freſh water, terminates; that liquor will iſſue out, notwithſtanding the reſiſtance of the ocean.

Illuſtrated and proved by experiment;

At once to illuſtrate and prove this paradox, I took a veſſel of a convenient depth, and a ſyphon of a proportionable length, both of them glaſs, that their tranſparency might permit us to ſee all that paſſed within them. Into the larger veſſel we put a quantity of ſea-water, and into the longer leg of the ſyphon; which was inverted, we poured a convenient quantity of freſh water; and kept it from running out at the ſhorter leg, by ſtopping the orifice of the longer with the finger: then this ſyphon being ſo placed in the larger veſſel, that the orifice of the ſhorter leg was far beneath the ſurface of the ſalt-water; and the ſuperficies of the freſh water in the longer leg, a pretty deal higher than that of the ſurrounding ſalt-water; we unſtopped the orifice of the upper leg, whereby the water in the ſyphon tending to reduce it ſelf to an *Æquilibrium* in both legs, the water in the upper, being much higher and heavier than that in the other, by ſubſiding, drove away the water in the ſhorter leg, and made it ſpring out at the orifice thereof, in ſpite of the breadth and ſpecific gravity of the ſalt-water. And this impulſe of the freſh water upwards, laſted as long as the ſurface of that water in the longer leg, retained its due height above that of the ſurrounding ſea-water.

And to make this experiment the more viſible, I perform'd it with freſh water, tinged with brazil or log-wood; but to prevent its being objected, that thereby the ſpecific gravity of the liquor would be altered or increaſed; I afterwards choſe to make it with claret wine, which, being lighter than common water, and of a conſpicuous colour, is very convenient for the purpoſe. When placing the orifice of the ſhorter leg, at a convenient diſtance below the ſurface of the ſea-water, 'twas pleaſant to obſerve, how upon the removal of the finger that ſtopp'd the orifice of the longer, the quick deſcent of the wine contained in it, impell'd the colour'd liquor in the ſhorter leg, and made it ſpring up at its orifice into the incumbent ſea-water, in the form of little red clouds, and ſometimes of very ſlender ſtreams. And as this ſhorter leg of the ſyphon was raiſed more and more towards the ſurface of the water, ſo there iſſued out more and more wine at the orifice of it; the liquor in the longer leg proportionably ſubſiding, yet continuing manifeſtly higher than the ſurface of the ſalt-water, than which it was *in ſpecie* lighter.

The true cauſe of ſaltneſs in the ſea.

The true cauſe of the ſaltneſs of the ſea, I, with the moderns, aſcribe to the ſalt that is diſſolved in it: but I take that ſaltneſs to be ſupplied, not only from rocks, and other maſſes of ſalt, which at the beginning were, or in ſome places may yet be found, either at the bottom of the ſea, or at the ſides, where the water can reach them; but alſo from the ſalt, which the rains, rivers, and other waters, diſſolve in their paſſage through many parts of the earth; and at length carry along with them into the ſea. For 'tis manifeſt, that ſeveral countries afford ſalt-ſprings, and other running waters, that at length terminate their courſe in the ſea; and I have ſometimes ſuſpected, that very frequently the earth it ſelf is impregnated with corpuſcles, or at leaſt, rudiments of common ſalt; though no ſuch thing be vulgarly taken notice of. For eminent chymiſts, affirm themſelves to have found a conſiderable quantity of an exceeding ſaline liquor, upon the evaporation of large quantities of ſome waters: and a large quantity of common ſalt, is uſually found in the refining of ſalt-petre; a ſalt, which, as experienced writers teach, almoſt every fat earth, kept from the ſun and rain, and from ſpending it ſelf in vegetation, will afford.

And ſince the earth abounds with common ſalt, in many more places than are uſually obſerved; and ſince 'tis probable, that by maturation, or otherwiſe, ſalt may daily grow in the earth; 'tis obvious, that our common terreſtrial ſalt being diſſolved, may ſuffice to make the ſea-water brackiſh: the ocean too, may receive ſupplies of ſalt from rocks and ſprings latent in its own boſom; which, poſſibly, is one reaſon, why ſome ſeas are ſo much ſalter than others.

And as our common terreſtrial ſalt, may be communicated to the ſea in plenty enough to impregnate it with as much ſaltneſs as we obſerve it to have; ſo the difference between that ſalt and ſea-ſalt ſeems not too great, to be derived from thoſe changes that the terreſtrial ſalt may be liable to, when it comes into the ſea. For that the marine ſalt, and the terreſtrial, very well agree in the general, may be argued from the reſemblance in ſhape, taſt, *&c.* obſerved between the grains produced by expoſing each of them, in a diſtinct glaſs, to ſuch a heat, as may ſlowly carry off the ſuperfluous moiſture, and ſuffer them to coagulate into cubical grains: and the leſs differences that may be met with between theſe two ſalts, may well be ſuppoſed producible by the plenty of nitrous, urinous, and other ſaline and bituminous bodies, that by land-floods, and otherwiſe, are from time to time carried into the ſea; and by ſeveral things that happen to it there, eſpecially by the various agitation 'tis put into by tides, winds, currents, *&c.*

To make ſea water freſh by diſtillation.

We may juſtly be the more careful to determine, whether the ſaltneſs of the ſea-water proceeds from common ſalt diſſolved in it, becauſe if it appeared to be ſo, we might the more hopefully attempt to obtain, by diſtillation, ſweet water from ſea-water; ſince, if this liquor be made by the bare diſſolution of common ſalt in the other, 'tis probable, that a ſeparation may be made of them, by ſuch a heat, as will eaſily raiſe the aqueous parts of ſea-water, without raiſing the ſaline. And ſuch a method of ſeparating freſh water, from that which was ſalt, would make our doctrine of uſe, and be very beneficial to navigation, and conſequently to mankind. For in long voyages, 'tis but too common to be liable to hazards and inconveniencies, for want of freſh and ſweet water; whereby men are ſometimes forced to drink corrupt, brackiſh water, which gives them ſeveral diſeaſes, particularly the ſcurvy, and the dropſie. And ſea-men receive ſo many other inconveniencies thro' the want of freſh water, that, to prevent, or ſupply it, they are often forced to change their courſe, and ſail ſome hundred of miles to a dangerous coaſt, by which means they often loſe the benefit of their trade-winds, and frequently of their voyage. And theſe are inconveniencies which might be, in good meaſure, prevented, if potable, and tolerably wholeſome water, could be obtained by diſtillation, in the midſt of the ſea it ſelf; to ſerve the ſailors till they could be ſupplied with natural freſh water. To attempt this, I took ſome *Engliſh* ſea-water, whence I was able to ſeparate betwixt a thirtieth and fortieth part of dry ſalt; and having diſtilled it in a glaſs-head and body, with a moderate fire, till a conſiderable portion of it was drawn over, we could not diſcern any ſaltneſs in it by the taſt; beſides, I found it ſpecifically lighter than ſuch water as is daily drunk by perſons of quality at *London*. I afterwards expoſed it to a more chymical examination, and did not by that find any thing of ſea-ſalt in it; tho' I have ſeveral times, by the ſame way, manifeſtly diſcovered a ſaltneſs in inland-waters, that are uſed for ſweet. If I would have employed a ſtronger heat, and veſſels larger and lower, or otherwiſe better contrived for great diſtillation, I might, in a ſhorter time, have obtain'd much more diſtill'd water: but whether ſuch liquors will be altogether ſo wholeſom, experience muſt determine. Yet that ſea-water, diſtill'd even in no very artificial way, may be ſo far wholeſom, as not ſoon to be ſenſibly noxious, may be gathered from the teſtimony of that famous navigator Sir *R. Hawkins*, who commanded a fleet, in the *Indies*, for queen *Elizabeth*. For he, in the judicious account he gave of his voyage, wherein they were diſtreſſed, even in the admiral's ſhip, for want of freſh water, has this memorable paſſage. “ Altho' our freſh water had fail'd us many days “ (before we ſaw the ſhore) yet with an invention I had in my ſhip, “ I eaſily drew out of the water of the ſea ſufficient quantity of freſh “ water, to ſuſtain my people, with little expence of fewel; for with “ four billets I ſtill'd a hogſhead of water, and therewith dreſſed meat “ for the ſick and whole. The water ſo diſtill'd we found to be “ wholſom and nouriſhing.”

Liquors diſtilled from ſea-water, chymically examin'd.

And becauſe the potableneſs of ſea-water may concern the healths and lives of men, I ſhall here add two or three obſervations I made upon thoſe few diſtill'd liquors, I had occaſion to draw from ſea-water. Having then, upon ſome of the diſtill'd liquor, dropt a little oil of tartar *per deliquium*, I perceiv'd no clouds at all, or precipitation to be made; tho' a ſmall proportion of that liquor being dropt into the undiſtill'd ſea-water, would preſently trouble and make it opake; and, tho' ſlowly, ſtrike down a conſiderable deal of a whitiſh ſubſtance. I found, alſo, that a very ſmall proportion of an urinous ſpirit, ſuch as that of ſal-armoniac, would produce a whitiſh and curdled ſubſtance in ſea-water, before it was expoſed to diſtillation, but not in the liquor drawn from it: which argued, that there were but few or no ſaline particles of ſea-ſalt aſcended with the water; otherwiſe theſe alcalizate and urinous ſalts would, in all likelihood, have found them out, and had a viſible operation on them. I farther remember, that when the diſtillation was made in glaſs veſſels, with an eaſie fire; not only the firſt running, but the liquor that came over afterwards, was not perceived to be brackiſh, but good and potable. And by a hydroſtatical tryal, I found our diſtill'd ſea-water to be lighter *in ſpecie* than common conduit water, but heavier than diſtill'd rain-water.

To return, it may be objected, that if the terreſtrial ſalts, carried by ſprings, rivers, and land-floods, into the ſea, were the cauſe of its ſaline taſt, thoſe waters themſelves muſt be made ſalt by it, before they arrive at the ſea. But this objection will not reach the ſprings and rivers of ſalt-water, that in ſeveral places, either immediately or mediately diſcharge themſelves into the ſea. However, I take it to be only a partial cauſe, that contributes to the degree of ſaltneſs obſerved in the ocean, where this imported ſalt may join it ſelf with that it finds there already, and being detained by it, contribute to the brineſs of the water.

If it be urg'd, that from hence the ſea muſt increaſe in ſaltneſs, I may ſuſpend my anſwer till it appear by competent obſervation, that it does not; which, I think, we have no tryals to warrant. And if the matter of fact were certain, I think it poſſible to give a farther anſwer, and ſhew probable ways, how ſo ſmall an addition of ſalt may be diſpers'd by nature, and kept from increaſing too much.

The cauſe of the bitterneſs in ſea-water.

But the taſt of ſea-water is not ſuch a ſimple ſaline taſt, as ſpring-water would receive from *Sal gemma*, or ſome other pure terreſtrial ſalt diſſolved in it; but a bitteriſh one, that muſt be derived from ſome peculiar cauſe which authors commonly overlook. I am not aſſur'd by any obſervations of my own, that this receſs from a purely ſaline taſt, is likely to be of the very ſame kind, and to be equally met with, in all ſeas. The cauſe both of the bitterneſs and ſaltneſs of the ſea-water, is ſaid to be aduſt and bituminous exhalations aſcending out of the earth into the ſea. Now, that there is abundance of actual ſalt in the ſea-water, to give the ſaline taſt and weight it has, the ſalt, that the ſun, in many places, plentifully ſeparates from the ſaltleſs wateriſh parts, ſufficiently manifeſts. But as to the bitteriſh taſt, I think it no eaſie matter to give a true account of it; tho' I am apt to aſcribe it to the operation of ſome general agents upon the vaſt ocean, and to the alteration that the ſalt receives from the mixture of ſome other things, among which bitumen may be one of the principal.

But tho' in ſome places of the ſea there are conſiderable quantities of bitumen, or bituminous matter; yet I dare not derive the bitterneſs of the ſea wholly from bituminous exhalations, but in good part, at leaſt in ſome places, from the liquid and other bitumen, that is imported by ſprings and other waters into the ſea; of which we have an eminent inſtance in *Barbadoes* tar, according to the relation I had of it from an inquiſitive gentleman, who is one of the chief planters of the iſland, and took pleaſure to obſerve this liquid bitumen to be carried in conſiderable quantities from the rocks into the ſea: and I think it poſſible enough, that ſome of the ſprings which riſe under the ſurface of the ſea, may carry up with them bituminous matter, contributing to make the ſaltneſs of the ſea degenerate; as I have ſuſpected, that in ſome places the ſulphureous exhalations, and other effluvia from the ſubmarine parts of the earth, may, ſometimes, contribute to change the ſaline taſt of the ſea-water: for not only ſulphureous ſteams, but ſometimes actual flames, have broken through from the lower parts of the ſea to the upper; and I have ſometimes made, by art, a rude imitation of that phenomenon. Some experiments, alſo, of my own, and other inducements, have perſuaded me, that, ſometimes, ſea-ſalt does not obſcurely participate of combuſtible ſulphur. But as the taſt of the ſea-water is not in all parts of the ocean uniform, it might ſuffice to take notice in general, that this difference may, in ſome meaſure, be caus'd by adventitious bodies of ſeveral kinds; of which 'tis probable, that in different places the ſea-water variouſly partakes. And not to mention here the fragrant ſmell of violets, which has by ſeveral, and particularly by an eminent perſon, of whom I enquired about it, been obſerved, in ſome hot countries, to proceed from ſea-ſalt; I have many other reaſons to think, that it is uſually no ſimple ſalt, nor free from mixture. For by more ways than one, and particularly by cohobating it from its own ſpirit, we have obtained a dry ſublimate, which ſeemed to be a compounded body.

And I have ſuſpected, that the various motion of the ſea, and its being expoſed to the action of the air and ſun, may contribute to give it a taſt other than ſaline; ſince ſea-ſalt, by being barely expos'd for many months to the air, and ſometimes, perhaps, put into a gentle agitation by a digeſtive heat, I found acquired a very different taſt from the ſimple ſolution of ſea-ſalt in common water.

It appears, alſo, by what I have learned from navigators, about the manifeſt various colours, and other qualities of the different parts of the ſea, that 'tis not every where of ſuch an uniform ſubſtance as men vulgarly imagin; and that vaſt tracts of it are imbued with ſtupendous multitudes of adventitious corpuſcles, which, by ſeveral ways, diverſifying its parts, keep it from being a ſimple ſolution of ſalt. And becauſe 'tis generally thought, that the ſea-water is, by reaſon of the ſalt it abounds with, uncapable of putrefaction; I will add, that having kept a quantity of ſea-water, which I had cauſed to be purpoſely taken up between the *Engliſh* and *French* ſhores, in a good new rundlet, a place where the ſummer ſun beat freely from, it did, in a few weeks, acquire a ſtrongly fetid ſmell. But a navigator of my acquaintance, having often ſailed in the *Indian* and *African* ſeas, told me, that being once, tho' it was in the month of *March*, becalmed, in a place, for twelve or fourteen days, the ſea, for want of motion, and by reaſon of the heat, began to ſtink; ſo that, he thinks, if the calm had continued much longer, the ſtench would have poiſoned him. They were freed from it as ſoon as the wind began to agitate the water, and broke the ſuperficies; which alſo drove away ſhoals of the ſea tortoiſes, and a ſort of fiſh, that before lay basking on the top of the water.

And Sir *R. Hawkins* takes notice; that “ were it not for the moving “ of the ſea by the force of winds, tides, and currents, it would “ corrupt all the world. The experience I ſaw, ſays he, in the year “ 1590, lying with a fleet about the iſlands of *Azores*, almoſt ſix months, “ the greateſt part of the time we were becalmed; with which all the ſea “ became ſo repleniſhed with ſeveral ſorts of gellies, and forms of ſer- “ pents, adders, and ſnakes, as ſeemed wonderful; ſome green, ſome “ black, ſome yellow, ſome white, ſome of divers colours, and many “ of them had life; and ſome there were a yard and a half, and “ two yards long; which, had I not ſeen, I could hardly have be- “ lieved. And hereof are witneſſes all the company of the ſhips “ which were then preſent; ſo that hardly a man could draw a “ bucket of water clear of ſome corruption. In which voyage, “ towards the end thereof, many of every ſhip fell ſick of this “ diſeaſe, and began to die apace; but that the ſpeedy paſſage into “ our country, was a remedy to the crazed, and a preſervative for “ thoſe that were not touched.”

Various degrees of ſaltneſs in different parts of the ſea.

As to the various degrees of the ſea's ſaltneſs, authors are ſilent; only a few navigators tell us, they obſerve ſome ſeas to have a more, and others a leſs ſaline taſt.

To gain, therefore, ſome light in this matter: to a learned man who was to ſail to places of different latitudes in the torrid zone, I delivered a glaſs inſtrument, fitted, by the greater or leſs emerſion of the upper part, to ſhew, accurately enough for uſe, the greater or leſs ſpecific gravity of the ſalt-water it was ſet to ſwim in. This he put, from time to time, into the ſea-water, as he ſailed towards the *Indies*; whence he wrote me word; that “ he found, by “ the glaſs, the ſea-water to increaſe in weight, the nearer he came “ to the line; till he arrived at a certain degree of latitude, as he “ remembers, about the thirtieth; after which, the water ſeemed “ to retain the ſame ſpecific gravity, till he came to *Barbadoes* or “ *Jamaica*.”

Another obſervation I obtained, by inquiry, of an ingenious perſon, and a ſcholar, at his return from the *Eaſt-Indies*; who affirm'd to me, that he, and a gentleman of my acquaintance, took up bottles full of ſea-water, under the equinoctial, and off the cape of *Good Hope*, which lies in about 34 degrees of ſouth latitude; and found the waters of theſe diſtant parts of the ocean, to be of the ſame weight.

In a letter from *Muſilapatan*, on the gulf of *Bengale*, in the *Eaſt-Indies*, written by Sir *William Langhorn*, who is intruſted with the care of the *Engliſh* factories in thoſe parts, I have the following account: “ Off the cape, in 37 *d.* 00 *m.* ſouth latitude, I took up “ ſome ſea-water, and kept it till I came to the line again; and “ then compared it with the water there; filling the ſame bottle “ again to the ſame height by a mark, and found it exactly of the “ ſame weight.”

Inquiring of an obſerving perſon, who had been at *Moſambique*, which is thought to be one of the hotteſt places in the world, whether he did not there find the ſea to be more than ordinarily ſalt? he anſwered me, that, coming thither in a great carack, when he returned from the town to the ſhip, he obſerved near two hands breadth of the veſſel riſen above the ordinary part, to which it uſed to ſink; ſo that he took notice of it to the captain, as fearing that part of the lading had been, by ſtealth, carried to ſhore: but the pilot, who had made thirteen or fourteen voyages to the *Indies*, aſſur'd him, what he had obſerved about the ſhip was uſual in that place, where the taſt diſcovered the water to be exceeding ſalt.

Nor need we ſcruple to allow, that ſome ſea-waters may be very much more impregnated with ſalt than ours; for water will naturally diſſolve, and retain a far greater proportion of ſalt, than that which is commonly met with in the ſea. A thirty fifth, a thirtieth, or, at moſt, a twenty fifth part of ſalt, will make water more ſaline, than it is found in many ſeas: and a friend of mine, who is maſter of a ſalt-work, informed me, that the water of his ſprings affords him a twelfth part of good white ſalt; and that another ſpring not far off, yields no leſs than an eighth part.

Experiments to diſcover the weight of ſea-water.

To come to my own experiments that I made about the gravity of ſea-water, which I order'd to be taken up, ſome at the depth of about fifteen fathoms near our ſhore, and ſome in another place of the channel between *England* and *France*.

We took a vial, with a long and ſtrait neck, and having counterpois'd it, we filled it to a certain height with common conduit water: we noted the weight of that liquor; which being poured out, the vial was filled to the ſame height with ſea-water, taken up at the ſurface; and by the difference between the two weights, the ſea-water appeared to be about a forty fifth part heavier than the other.

We carefully counterpois'd a piece of ſulphur in the upper ſea-water; it weigh'd ʒ *ſs.* 10½ *gr.* and being alſo weigh'd in ſea-water fetch'd from the bottom, it gave us the ſame weight; which ſhewed thoſe two waters to be of the ſame ſpecific gravity. We then weigh'd the ſame ſulphur in common conduit water, and found it ʒ *ſs.* 15½ *gr.* By which it appeared, that the ſea-water was but about a fifty third part heavier than this water: which is ſuch a difference from the proportion found in the former way of trial, that I could not imagine what to attribute it to; unleſs the ſea-water, by long ſtanding in a veſſel, which, though covered, was expos'd to the hot ſun, might both have been rarified, and have had ſome ſeparation made of its ſaline, or other heavier parts; on which account, that portion we took up for our trial, might appear lighter than elſe it would have done; or unleſs (the experiment having been made in *London*, where great and ſudden rains, and other accidents, will ſometimes viſibly vary the conſiſtence of common water;) the liquor I then employed, without examining it, might be more ponderous at that time than at another. To the latter ſuſpicion I was the more inclined; becauſe, having afterwards weighed the ſame piece of ſulphur, by help of the ſame balance, in diſtilled rain-water, I found the weight of the former liquor, to exceed that of the latter, by leſs, conſiderably, than a thirty fifth part; which ſeemed to make it probable, that if the water, we chanced to employ, had been free from all ſaline, and other heavy particles, the difference betwixt this obſervation and the foregoing, would not have been near ſo great as it was.

Again, a pound, *averdupois*, of the upper ſea-water, was weigh'd out, and put into a head and body, to be diſtilled in a digeſtive furnace *ad ſiccitatem*; and the diſtillation being leiſurely made, the bottom of the glaſs was almoſt cover'd with fair grains of ſalt, ſhot into cubical figures, and more white than we expected: in the reſt of the coagulated matter we took no notice of any determinate ſhape. The ſalt being weighed, amounted to ℥ſs. *averdupois*, and 10*gr.* At which rate the proportion of the ſalt to the water, will amount to near the thirtieth part; which was ſo much greater than the former ways of trial, made us expect, that, perhaps, it may be worth while to examine, whether ſuch a ſlow abſtraction as we made of the ſuperfluous water, in cloſe veſſels, may not have afforded us more ſalt than otherwiſe we ſhould have obtained.

But ſuſpecting that ſomewhat elſe might have concurr'd, to yield ſo great a proportion of ſalt; I ſuffered that which had been weigh'd, to continue a while in the ſcale, and ſoon perceived, that the ſcale began manifeſtly to preponderate; and, conſequently, that ſome of the unexpected weight of ſalt might be due to the moiſture of the air, imbibed after the ſalt was taken out of the glaſs, and laid by to be weighed. Wherefore, cauſing it to be very well heated and dried in a crucible, we found it to weigh 210*gr.* whence the proportion of ſalt contained in the water was about a thirty ſeventh part.

From whence this greater proportion of ſalt by diſtillation, than our other trials made us to expect, proceeded, ſeems not eaſie to determine; unleſs it be ſuppoſed, that the operation whereto the ſea-water was expoſed, made ſome great change in it; and that, though the ſalt we gained out of the ſea-water, ſeemed to be dry before we weigh'd it; yet the ſaline corpuſcles, upon concreting into cubes, ſo intercepted many ſmall particles of water between them, that they could not be driven away by a moderate

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It might not be amiſs, that obſervations were heedfully made, to ſhew, whether in the ſame ſea, and about the ſame part of it, the water is always equally ſalt. For, though that be taken for granted, yet ſince we have no good, ancient obſervations, to eaſe the ſuſpicion, 'tis not improbable, that, at leaſt in many places, the ſaltneſs of the ſea may continually increaſe by the acceſſion of thoſe ſaline corpuſcles that are imported by ſalt-ſprings; and thoſe which rivers and land-floods from time to time rob the earth of. And it ſeems not impoſſible, that a particular part of the ſea may be ſometimes extraordinarily, and perhaps ſuddenly, impregnated with an additional ſaltneſs, from ſaline ſteams plentifully aſcending into it, by means of ſubterraneal fires. But it may prove the more difficult to diſcern this adventitious ſaltneſs, unleſs the taſt, as well as the balance, be employed about it; becauſe the ſalt that produces it, may be of ſuch a nature, as to be much lighter *in ſpecie* than common ſea-ſalt.

Though the weight of ſea-water, be as good a way as any yet employed, to determine what part of it moſt abounds in ſalt; and though it be poſſible, that in our ſea, and, perhaps, in almoſt all others, this way is not liable to any conſiderable uncertainty; yet it may ſometimes deceive us, eſpecially in very hot regions; becauſe I have obſerved, that there are volatile ſalts, which, though by reaſon of their activity, they make ſmart impreſſions on the tongue, and give the water imbued with them a ſtrong, ſaline taſt, yet add very little to its ſpecific gravity: as I have tried, by hydroſtatically examining diſtilled liquors, impregnated with volatile and urinous ſalts; ſome of which liquors I found very little heavier than common water, and, conſequently, nothing near ſo much heavier as they would have been made, if they had been brought to ſo ſharp a taſt, by having nothing but common ſea-ſalt diſſolved in them. And therefore, if in any particular place, by any other way, or from the ſteams of the earth beneath, the ſea ſhould be largely impregnated with ſuch kind of light ſalts, the ſea-water may be much more ſalt to the taſt, and yet be very little heavier. Thus a ſealed bubble of glaſs, made heavy by an included metal, weighed firſt in ſpirit of ſal-armoniac, that taſted much ſtronger than ſea-water, ʒ iij. 51 ¼ *gr.* and afterwards, in fair water, but ʒ iij. 45 ¼ *gr.* So that notwithſtanding its great ſaltneſs, the ſpirit was lighter than common water; though a large part of that comparative levity may, probably, be aſcribed to the liquor wherein the ſaline particles ſwam; which, by diſtillation, was grown more pure and light than common clean water.

But for a farther proof, we took a hard lump of ſal-armoniac, and a lump of good white ſea-ſalt, and found the proportion of the latter to a bulk of water equal to it, ſomething above that of two and a quarter to one; and the proportion of the former, to an equal bulk of water, not above a centeſm more than that of one and $\frac{7}{10}$ to one; which falls ſo ſhort of the other proportion, that it may juſtly ſeem ſtrange; eſpecially if it be conſidered, that the factitious ſal-armoniac which chymiſts generally uſe, and we employ, conſiſts, in good part, of ſea-ſalt, which abates much of the comparative levity it might have, if it were made up only of urinous and fuliginous ſalts, which are its other ingredients.

I ſhall here add the greateſt meaſure of ſaltneſs whereto I have brought water, without the help of external heat. To which purpoſe, I employed two different ways; the one was, by putting into a well-counterpoiſed vial, two ounces of common water; and then adding to it, well dried and white common ſalt; and ſhaking them together, till the liquor would, whilſt cold, diſſolve no more, this liquor, thus glutted with ſalt, weighed 1150 grains; from which two ounces being deducted, the overplus of weight, ariſing from the diſſolved ſalt, amounted to 190 grains; ſo that a parcel of ſalt will, without heat, be diſſolved in about five times its weight of common water. By which proportion we made ſo ſtrong a brine, that ſeveral pieces of amber, being purpoſely let fall into it, emerged, and floated on it. The better way, tho' more tedious, that we made uſe of was, to let ſea-ſalt run *per deliquium*, till it was diſſolved by the aqueous vapours that ſwim in the air. In this liquor we weighed a piece of ſulphur, which we alſo weighed in ſea-water, wherein, finding it much heavier than in the former, it appeared that the ſea-water was *in ſpecie* much lighter than the other; but how much, I cannot remember.

I have alſo examined a hard, dry lump of ſea-ſalt, and found its proportion in weight to common water of the ſame bulk, to be almoſt as 2 to 1. But the ſpecific weight of a hard and figured lump of *Sal Gem.* proved to that of water very nearly as 2 ⅛ to 1.*

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* Dr. *Halley* thinks it adviſable, that the preſent degree of the ſaltneſs of the ſea ſhould be recorded, for the ſake of poſterity,

To examine the freſhneſs of waters.

Conſidering that various metalline and mineral ſolutions, might be readily precipitated, not only by the ſpirit of ſalt, but by crude ſalt, whether dry or diſſolved in water; 'twas eaſie to imagin, that, by means of this precipitating quality of common ſalt, one might diſcover whether any particles of it lay conceal'd in a propoſed liquor.

To this end I employed ſeveral preparations; and tho' two or three of my other tryals had a tolerable ſucceſs, yet that which, at length, I pitch'd upon as the moſt certain, is the following.

I took ſome common water diſtill'd in glaſs veſſels, that it might leave its corporeal ſalt, if it had any, behind; and put into a thouſand grains of it, one grain of dry common ſalt: into a convenient quantity, two or three ſpoonfuls, for example, of this impregnated liquor, I let fall a fit proportion, for inſtance, four or five drops, of a very ſtrong and well filtred ſolution of well-refined ſilver, diſſolved in clean *Aqua fortis.* I alſo made the tryal ſucceed with ſpirit of nitre; and herein, there immediately appeared a whitiſh cloud, that ſlowly deſcended to the bottom, and ſettled there in a white precipitate.

This experiment being ſeveral times repeated, was conſtant to ſucceſs, having recommended it to me for between twenty and thirty years; tho' I make choice hereof without denying, that men of ſagacity, eſpecially if well vers'd in chymical operations, may, upon the ſame foundation, find ſome other cheaper way, tho' ſcarce any more nice and certain, of compaſſing the ſame end.

But to make the experiment rigorouſly, we uſually took ſomewhat more than a thouſand parts of water to one of ſalt. And having let fall a few drops of our metalline ſolution, into a liquor obtained by a particular way of edulcorating ſea-water, there did not preſently enſue any white cloud or precipitate, much leſs ſuch an one as was afforded by the water, impregnated with leſs than a thouſandth part of ſalt. And if, after ſome time, there happen'd to appear a little cloudineſs in this factitious liquor, it was both ſlowlier produc'd, and much leſs than that which appear'd in the impregnated water.

Various ſolutions of mineral bodies may, alſo, be precipitated by dilution; that is, when the ſolution has time enough allow'd to diffuſe it ſelf, through a great quantity of water, the ſaline parts are thereby ſo attenuated and weaken'd, that they remain no longer able to ſuſtain the mineral corpuſcles, they kept afloat before; but make with them and the water, a confus'd ſubſiding mixture, uſually of a whitiſh co-

rity, who, as he ſuppoſes, may, from the continual increaſe hereof, at length, diſcover the age of the world. The Doctor wiſhes the ſame thing had been done 2000 years ago, that we might have been at ſome certainty in this affair. For as the rivers, according to his hypotheſis, gradually waſh away the ſalt of the earth, and depoſit it in the main ocean, this muſt continually become more ſaline thereby; whence, two experiments made at large but equal diſtances of time, might, by the rule of proportion, tell us how long the ſea has been in acquiring its preſent degree of ſaltneſs. See *Philoſ. Tranſact.* N° 344. *p.* 296.

lour. This appears when the butter of antimony, being put into common water, is thereby quickly and plentifully precipitated in the form of that white powder, the chymiſts call *Mercurius vitæ.* I have alſo produc'd a powder of that colour, by pouring into common water a ſtrong ſolution of tin-glaſs made in *Aqua fortis*: and by the ſame way have precipitated the tincture of jalap, benjamin, labdanum, antimonial ſulphur, and of other bodies, made in vinous ſpirits. Were it not for this power, that water has to weaken moſt ſolutions of bodies, I could have employ'd, inſtead of ſilver, either quick-ſilver diſſolv'd in *Aqua fortis*, or lead, crude or calcin'd, in the ſame liquor, or rather in ſtrong ſpirit of vinegar; ſince theſe, and ſome others, are found precipitable by ſalt-water into whitiſh powders. But tho' a very careful obſerver may make uſe of theſe metalline ſolutions, to gueſs at the quality of water, as to freſhneſs and ſaltneſs; yet the precipitation made by dilution, is not difficult to be diſtinguiſh'd from that which is perform'd by a true and proper precipitant, both by the quickneſs of the effect, and the copiouſneſs of the white ſubſtance produc'd; being on both theſe accounts very much inferior to it: as may evidently appear in the very different effects that our particular ſolution has upon the ſea-water, peculiarly edulcorated, and upon well diſtill'd common water, compar'd with thoſe it had upon water impregnated with a thouſandth part of ſalt, and upon ſeveral common undiſtilled waters.

To proceed, the uſefulneſs of this experiment is not to be eſtimated barely by the eſſay it helps us to make of dulcify'd waters, but much more by the eſtimate, that by its means may be made of natural freſh waters, whether of ſprings, rivers, lakes, wells, *&c.* For it being generally granted, that thoſe waters, *cæteris paribus*, are the beſt, as well for wholeſomneſs, as other various œconomical uſes, *&c.* that are freeſt from ſaltneſs; which is an adventitious, and in moſt caſes, a hurtful quality in waters; by our way of examining theſe liquors, a heedful eye may in a trice diſcover, whether there be any latent ſaltneſs in them, and enable us, eſpecially by the help of a little practice, to give a near gueſs, how much one water is freſher than another; as I have purpoſely try'd in different waters, that were ordinarily drunk by conſiderable perſons. And if once you have attentively mark'd what change four or five drops, for inſtance, of our liquor, will make in two or three ſpoonfuls, or half ounces of water; 'twill not be difficult for a heedful obſerver, keeping the ſame proportion between the two liquors, to make a near eſtimate, whether any natural water propos'd have a greater, an equal, or a leſs degree of freſhneſs or ſaltneſs, than that he has choſe for a ſtandard; and how much, in caſe there be a difference, the propos'd liquor is more or leſs free from ſaltneſs than the other.

And that ſuch a difference in a liquor of ſuch frequent internal uſe as water, may have conſiderable effects upon human bodies, in reſpect of health, may be, probably, argued from the differing effects waters, more or leſs impregnated with ſalt, have upon ſeveral other bodies. Moſt pump-waters, for inſtance, will not boil peaſe and beef, *&c.* near ſo well as ſpring or rain-water, which is uſually ſofter, and more free from the ſaltneſs we ſpeak of. 'Tis commonly known, that the ſame pump-water will not ſo well and uniformly, or without curdling, diſſolve waſh-balls and ſoap, as rain-water, and ſome running waters: nay, it has been confeſs'd by ſkilful artiſts, that ſome tools, as gravers, *&c.* made of the hardeſt ſteel, would receive a different temper if quench'd in pump-water, from that which the like extinction in ſpring or river water, would give them.

And as many medicinal waters, that are preſum'd to owe their virtues to the participation either of metalline or mineral bodies, appear, upon tryal, to leave ſometimes little, and ſometimes nothing behind them, except a kind of common ſalt; our precipitant may greatly aſſiſt us to diſcover, whether a mineral water propos'd contain ſuch a ſalt; and if it do, whether copiouſly or no. This I have tried upon more than one of our *Engliſh* mineral waters, and thereby found immediately, that one reputed of another nature, contained pretty ſtore of ſaline matter; and that another is impregnated with a ſurprizing plenty of a ſaltiſh ſubſtance.

Tho', for certain reaſons, I aſcribe not to our method of examining waters, an ability to diſcover leſs than one part of ſalt in a thouſand parts of water; yet if it were requiſite, we might make more nice diſcoveries. For having, ſometimes, by means of it, put one grain of ſalt into fifteen hundred of diſtilled water, we could manifeſtly make it appear, that even this liquor, tho' ſo lightly impregnated, was not deſtitute of ſalt, but contained more of it than ſome of the peculiarly edulcorated water: nay, I once found, that a grain of dry ſalt, being diſperſed through two thouſand, and at another time that being diſſolved in three thouſand times its weight of the ſame kind of liquor, ſo inconſiderable a portion of ſalt was plainly diſcoverable by our precipitant.

But it may be objected, that as the experiments hitherto mentioned have been made only upon waters impregnated with groſs or corporeal ſea-ſalt; they may, nevertheleſs, be imbued with the ſpirit of that ſalt, which, by reaſon of its activity, ſhall prove as unhealthful to the drinker, as the groſſer ſalt it ſelf. To this I might anſwer, that a very ſmall proportion of ſpirit of ſalt, may, in many caſes, make the water ſeaſon'd with it, rather medicinal, than unwholeſom; but to manifeſt the foundation of the objection to be falſe, I took above a thouſand grains of diſtill'd water, and, inſtead of corporeal ſalt, put to it one ſingle drop of moderately ſtrong ſpirit of ſalt; and having ſhook it into the water, I let fall into a portion of this unequally compos'd mixture, ſome drops of our ſolution of ſilver, which preſently began to precipitate in a whitiſh form; ſo that, for ought appeared to the eye, this tryal ſucceeded better than if the water had been impregnated with

But a thouſandth part of corporeal ſalt. The like experiment was made with water peculiarly edulcorated. And further, diffuſing one drop of ſpirit of ſalt, into two thouſand grains of diſtilled rain water; and letting fall ſome drops of our precipitant into it, the ſucceſs well anſwer'd our expectation. But to urge the trial ſtill further, I added as much of the ſame diſtill'd rain water, as, by conjecture, amounted to at leaſt half as much more. So that one grain of ſpirit of ſalt had a manifeſt operation, tho' not quite ſo conſpicuous as the former, upon above three thouſand grains of ſaltleſs water; and poſſibly, if the vial could have contained more, and would not have been, when fill'd, too heavy for our tender balance, the diſcolouration of the mixture would have been diſcernable, tho' but one grain of ſpirit of ſalt had been put to four, or even five thouſand grains of water. And that a drop of the ſaline ſpirit we made uſe of, did not equal, in weight, a grain of dry ſalt, appeared from hence; that having let fall into a counterpois'd glaſs, ten drops of that ſpirit, I found them to weigh but about 8½ grains.

The like trial I made, by ſubſtituting above a thouſand grains of rain water, for the like quantity of diſtill'd water. And if five or ſix ſmall drops of ſtrong ſpirit of urine, were ſhaken into at leaſt a thouſand grains of diſtill'd or rain water, impregnated with but one of ſalt; our precipitant would make a diſcovery of ſome ſaltiſhneſs in the liquor. I have, alſo, found rain water, that I cauſ'd to be carefully ſav'd, after the houſe-tops whereon it fell, had been well waſh'd with former rain, to grow a little turbid, if any quantity of our precipitant were kept for a competent time in it. And being gently diſtill'd off, it left a reſidence, which, with a little of our ſolution, afforded a far more ſudden and copious precipitate, than had been produced with the like quantity even of pump water it ſelf. And tho' I have met with rain-water, that was more free from ſalt than any ſpring, or river-water, I remember to have examined; yet, having made trial of ſnow-water, which is thought be the lighteſt of all natural waters, I manifeſtly found it, by our way of examination, not to be deſtitute of ſaltneſs.

THE TEMPERATURE OF THE Subterranean and ſubmarine Regions, As to Heat and Cold.

SECT. I.

Different regions, below the ſurface of the earth.

A Chymiſt, who purpoſely travelled to viſit *Hungary*, and other places famous for mines, aſſured me, that upon his deſcent into a mine of an exceeding great depth, he felt the air yet warm near the orifice of the groove; but afterwards deſcending towards the lower parts, he perceived it cold, till he came to ſuch a depth as he ſcarce attained by deſcending for a quarter of an hour; and that the cold he felt during this time ſeemed conſiderable, eſpecially when he was got pretty low down; that after he had paſs'd this cold region, he began, by degrees, to come into a warmer; which increaſed in heat as he went deeper; ſo that in the lower veins he found the workmen digging, with only a ſlight garment upon them: and the ſubterraneal heat, he ſaid, was much greater than that of the free air on the top of the groove, tho' it were then ſummer.

This account of a cold region in the earth, has been ſince confirmed to me by a phyſician, from an obſervation made in another *Hungarian* mine, not of gold, but copper; and of a much leſs depth than the former. For in going down, he declared he felt a conſiderable degree of cold, and the like in his return upwards; that he began to feel the cold, when he could receive no more light by the mouth of the groove; and that this cold region laſted till he came near the bottom, which was eſtimated to be about 100 fathoms in a ſtrait line from the top.

This relation agrees very well with that of *Morinus*, who viſited the deep *Hungarian* mines in the month of *July*, and takes notice, that when he came down to the burrows, as he calls them, he did not find any heat, as at the mouth of the groove, but the beginning of a very cold, and conſiderably thick region. He further informs us, that when they had deſcended about 80 fathoms beneath the ſurface of the earth, he began to feel a breath of an almoſt lukewarm air; which increaſed as he deſcended lower: and adds, that the overſeer of the mine, who conducted him, affirmed, as did alſo the officers of other *Hungarian* mines, that in all their deep ones, after a thick tract of cold earth, there ſucceeds a lower region, which is always hot; and that after they arrived at ſuch a depth, they felt no more cold, how deep ſoever they dug.

There ſeem, therefore, to be three kinds of ſubterraneal regions, each of which deſerves a particular conſideration.

What we have to offer upon each may be thrown into the following propoſitions.

PROP. I.

The firſt region of the earth is very variable, both as to bounds and temperature.

For, the manifeſt operation of the ſun-beams, is, *cæteris paribus*, greater, and reaches farther in hot climates, than in cold ones; in the midſt of ſummer, than in the depth of winter. Beſides, in ſome places, the different ſolidity, or poroſity of the earth, as alſo the nature of ſome ſalts, marcaſites, and other bodies contained in it, may differently diſpoſe the ſoil to cold or heat. And in the firſt region, the air is uſually more temperate, than that above the ſurface of the earth; nor is this region conſiderably deep.

That in the upper region of the earth, it ſhould be leſs cold than above the ſurface, ſeems reaſonable; becauſe the ſubterraneal cavities are ſhelter'd by the thickneſs of the ſides, from the direct action of the ſun-beams, the wind, *&c.* and is alſo kept from an immediate, or full contact with the external air, when that is vehemently either heated or cool'd.

That the heat of the ſun much leſs powerfully affects ſuch places, as are ſhelter'd from its action by ſolid bodies, appears by the repoſitories of ice or ſnow, wherein 'tis kept during all the heat of ſummer; and that, oftentimes in cavities which are at no conſiderable depth beneath the ſuperficies of the earth. Nay, having had occaſion to keep ice for many weeks, after the froſty weather was gone, I did it, without either digging to a conſiderable depth in the ground, or building any ſubſtantial ſtructure over the cavity.

And a gentleman told me, that in the ſouthern part of *France*, where the heat ſeem'd to exceed that of ſeveral parts of *Italy*, ſome curious perſons, who reſolved to have ice in ſummer at any rate, tho' they could not dig four feet into the ground without meeting with water, they were yet able to make reſervatories, by covering a brick building, that ſtood over their pits, with clay and ſand, to a very conſiderable thickneſs; and taking care, that the only place which ſhould admit acceſs to the outward air, was a ſmall northern door, fitted exactly cloſe, and fenced with a little porch, furniſhed with another door. And by this means, he affirms, theſe gentlemen preſerv'd the ſame included ice, ſometimes for two or three years together.

And even where the intercourſe is not debarr'd betwixt the ſubterraneal and the ſuperior air, the operation of the ſun-beams may be very much leſs in a ſhallow cavity beneath the ſurface of the ground, than above it. For trials have informed me, that liquors, differing in little elſe than in conſiſtence, will not ſo eaſily pervade each other, as a man would imagine; unleſs ſome external motion promote their intimate mixture.

Deſcending, late in the morning, into a pit, where they were digging out iron-oar, tho' this cavity had no very narrow orifice, and was dug directly downwards, and exceeded not ten or twelve feet in depth; yet I found the heat no way troubleſom, while I ſtayed there, tho' the pit were in an open field, unſhaded by trees; and tho' the air abroad, were much heated at that time of the year, which was in the dog-days.

And as the ſubterraneal air, even in the firſt region, is uſually much leſs heated, than that above the earth; ſo the lower air is, *cæteris paribus*, much leſs refrigerated, by the grand efficients of cold, than the upper. For the ſubterraneal air, being, tho' comparatively cool, yet indeed moderately warm in ſummer, ought not be affected with the winter's cold, ſo much as that contiguous to the ſurface of the earth; from whoſe immediate contact it is defended by a thick arch: and that the cold reigns moſt in the free air, and the ſuperficial parts of the terreſtrial globe, appears, becauſe water begins to freeze at the top, not at the bottom. And, we ſee, that in cellars arched, and carefully kept cloſe from the communication of the outward air, beer, and other liquors, may be kept from freezing in froſty and ſnowy weather; as I have obſerved in a ſhallow cellar, but well arch'd, during a ſevere winter; which froze ſtronger liquors than beer, in another adjoining cellar, that differ'd not much from it in depth, but had not ſo thick and ſolid a roof. And even in *Ruſſia* it ſelf, where the cold is extreme, it reaches not near ſo deep as one would expect.

PROP. II.

The ſecond region of the earth ſeems to be generally cold, in compariſon of the other two.

It ſeems reaſonable, ſince the earth is naturally a body conſiſting of groſs and heavy parts, uſually much leſs agitated than thoſe of our organs of feeling, that it ſhould, as to ſenſe, be cold; and therefore that quality may be juſtly aſcribed to it, in a region, where, by its ſituation, it is kept from being conſiderably affected, either by the heat of the upper air, or by that of the deep parts of the earth; which are the two agents that ſeem, of all others, the moſt likely to put its parts into an unuſual motion; and thereby change its natural temper. And that the propoſition agrees with experience, may be gather'd from the foregoing relations.

But then this coldneſs aſcribed to the ſecond region of the earth, is to be underſtood comparatively to the other two. For otherwiſe, even this earth is not the *ſummum frigidum*; for I could never hear of any ice met with there, at any time of the year. Nay, thoſe who have deſcended far enough into this region, have not found the cold any where very great, or in ſome places not at all conſiderable. And indeed, at the mouth of deep grooves in mines, the ſteams that aſcend, often feel warm; tho' the outward air, where the obſervation is made, be affected with the heat of ſummer; which ſeems to argue, that the middle region of the earth, thro' which theſe ſteams muſt aſcend, is not very intenſely cold.

PROP. III.

In ſeveral places, which, by reaſon of their diſtance from the ſurface of the earth, might be referr'd to the middle region of it, the temperature of the air is very different, at the ſame ſeaſons of different years.

I have learn'd from ſeveral perſons, who have here, in ſeveral parts of *England*, had occaſion to deſcend into deep pits, or grooves, of different minerals; that they felt in ſummer-time, a remiſſion of the heat of the external air, as ſoon as ever they began to deſcend; and that this warmth did not ſo far decreaſe, as to end in any notable coldneſs, before they came into a deeper part of the earth, where that quality never troubled them. And I had it from a mathematician, who was often employed about lead-mines, that at ſuch depths as, according to *Morinus*, the ſecond region of the earth reaches, he obſerved it to be ſenſibly warm at all ſeaſons of the year.

Nor is it improbable, that the middle region of the earth ſhould be of different temperatures, in different parts, upon account of the variations, only, which the climate may produce, by being very much hotter, or very much colder, in one place, than in another; but from the peculiar conſtitution of the ſoil.

And this temper of the ſoil it ſelf may be diverſified, not only by its greater or leſs compactneſs, but from the nature of the ſprings, or ſubterraneous liquors, that may abound in it, or ſtrain thro' it into the groove; and that eſpecially by the minerals, as ſalts and marcaſites, that grow near the ſides of the well, or are brought thither by the waters.

Nature does not regulate her ſelf under ground by our imaginary diviſions; but produces marcaſites, ſalts, and other minerals, moſt frequently, perhaps, in what we call the lower region of the earth; yet ſometimes too in our upper, and often in our middle region. Let us then ſuppoſe, that in ſome places of the latter, there is a mine of that earth, naturally abounding with embryonated nitre, or other ſalt, that is apt to ſend out refrigerating effluvia, or by its contact to cool the air. Let us alſo ſuppoſe, that by the ſides of another well, of the ſame depth, there are numerous unripe minerals, in the proceſs of generation, or rather, a great quantity of marcaſitical earth, yet of ſo open and looſe a texture, that not only water, but air alſo, wou'd, in a few hours, evidently work upon it. And ſince, whilſt marcaſites ſlowly diſſolve, it has been obſerved, that many of them will conceive a conſiderable degree of heat; 'tis very probable, that the temperature of the earth, in the place abounding with theſe marcaſitical minerals, will be very warm, in compariſon of the temperature of the other place, where the ſoil plentifully produces nitrous and other refrigerating bodies; tho' both the places be ſuppos'd at the ſame diſtance from the ſurface of the earth, and conſequently in the ſame ſubterraneal region.

Upon the like grounds it may alſo be ſuſpected, that in the ſame place the temperature will not be always the ſame; even upon account of the ſoil. For ſome ſaline earths, that partake of the nature of marcaſites, admit a kind of gradual maturation, and perhaps other changes which ſeem ſpontaneous; and ſuch changes may happen the more remarkably in thoſe parts of ſuch bodies as are expoſed to the air, which are the parts placed at the ſides of the deep wells we are talking of.

Hence a mineral, to which either heat or cold is to be referr'd, may be more plentiful, ripe, and operative, at one time than at another; or, at length, all the earth capable of being aſſimilated by the mineral rudiments harbour'd in it, may be conſumed; or the mineral it ſelf arrive at a perfection of maturity, which will render its texture cloſe, and unfit to be penetrated, and wrought upon, as before, by the water, or other liquor, which occaſion'd its heat.

PROP. IV.

The third region of the earth has been obſerved to be conſtantly and ſenſibly, but not uniformly warm; being in ſome places conſiderably hot.

Almoſt all the deep grooves that mineraliſts have given us accounts of, and wherein men have wrought long enough, to take ſufficient notice of the temperature of the air, have been made in ſoils furniſhed with metalline ores, or other minerals, without which, men would not be at the charge of ſinking ſo very deep into, and maintaining workmen in them; ſo that experience has yet but ſlenderly, or, at leaſt, not ſufficiently informed us of the temperature of thoſe parts of the third region of the earth, that are not furniſh'd with ponderous minerals; and conſequently it has not informed us of the temperature of the lower region in general.

Having purpoſely inquired of ſeveral perſons, who had viſited and frequented the third region of the earth, in different countries and ſoils, and at different depths and ſeaſons of the year, I did not perceive that any of them had ever found it ſenſibly cold. And ſuſpecting, that, in ſome caſes, the narrowneſs of the cavities, wherein the diggers were reduced to work, might make the warmth, they felt, proceed, in great part, from the ſteams of their own bodies, and, perhaps, of the minerals, and from the difficulty of cooling the blood in the air clogg'd with effluvia; I inquired, whether the heat of the ſubterraneal air, in ſuch places, might not be referr'd to the like cauſes. But I was anſwered in the negative, particularly by an inquiſitive perſon, who had been in the deepeſt and hotteſt mines that have been viſited by any acquaintance of mine.

There are ſtill, I think, two principal cauſes to which we may, probably, refer the temperature of thoſe places where the air is but moderately warm.

And firſt, the coldneſs of winter may not be felt in the lower region of the earth; becauſe the air there is too remote from that above the earth, to be much affected with thoſe adventitious cauſes of cold, which make that quality intenſe in the open air. But poſſibly the poſitive cauſe of the actual warmth there, may proceed from thoſe deeper parts of the ſubterraneal region, which lie beneath the places where men have yet had occaſion to dig. For it ſeems probable, that, in theſe yet unpenetrated bowels of the earth, there are great ſtorehouſes, either of actual fires, or places conſiderably hot, or in ſome regions, of both; from which magazines of ſubterraneal heat, that quality is communicated, eſpecially by channels, clefts, *&c.* to the leſs deep parts of the earth, either by a propagation of it thro' the ſolution of the interpoſed part of the ſoil, or by a more eaſy diffuſion of the fire or its effects thro' the above-mentioned conveyances; or elſe by ſending upwards hot mineral exhalations and ſteams, which, by reaſon of the comparatively heavy materials, whereof they conſiſt, and of their being leſs diſpers'd nearer the parts from whence they proceed, are uſually more plentiful in the deeper parts of the earth, and ſomewhat affect them with the quality that they brought from the places where they were form'd.

That manifeſt ſteams are often found in grooves, eſpecially in deep ones, is evident by the damps which infeſt moſt of them; and this in diſtant regions, as ſeveral provinces of *Germany*, *Bohemia*, *Hungary*, &c. as alſo in ſeveral parts of *England*. By which it appears, that ſeveral of theſe exhalations aſcending from the entrails of the earth, are ſulphureous, bituminous, and, in ſome grooves, apt to take fire. However, the eaſie inflammability of bodies is not always a ſure proof of the actual ſenſible warmth of the minute parts they conſiſt of. For tho' ſalt-peter be very inflammable, yet being by ſolution, in fair water, reduced to inviſible corpuſcles, it highly refrigerates that liquor. Nor have I obſerved its fumes, when far from the fire, to have any heat ſenſible to the touch. And the like may be ſaid of the exhalations of highly rectified ſpirit of wine, which yet, we know, is

NAT. HIST. is it ſelf totally inflammable. Nay, large exhalations may aſcend from the lower parts of the earth, and yet be rather cold than hot. For I have made a mixture, that plentifully emitted ſteams, even whilſt its component ingredients, briskly acting upon one another, were conſiderably cold.

But having purpoſely inquired of an obſerving man, who frequented deep mines, wherein he had a conſiderable ſhare; he aſſured me, he plainly obſerv'd the fumes that came out of the mouths of them to be actually and ſenſibly warm, and this in a warm ſeaſon of the year. And *Morinus*, ſpeaking of the deep *Hungarian* mines, tells us, the large exhalation, that aſcended from the bottom, was hot. And that at the mouth of a well, the aſcending fumes were ſenſibly hot, even in ſummer.

That alſo in many places of the earth, where no grooves are dug, and no viſible exhalations taken notice of, effluvia may yet pervade the ſoil, and exerciſe ſome operations of warmth, appears, probably, from hence; that *Agricola* reckons it, among the ſigns of a latent mineral vein, that the hoar-froſt does not lie upon that tract of the ſurface of the earth, under which a vein runs. The like directions I have known given by the skilful in *England*, for the diſcovery of places that contain coal-mines. And a near relation of mine ſhew'd me a great tract of his land, which, he affirmed, would not ſuffer ſnow to lie upon it for above a day or two, in the midſt of winter.

A very ingenious gentleman, alſo, who lives among mines, and is concern'd in ſome of them, aſſured me, that in ſome places which he knew to have mineral veins beneath them, he obſerv'd, neither ſnow nor ice would continue ſcarce at all upon the ſurface of the ground, even in an extraordinary cold winter. And ſome learned men tell us, that near the gold-mines in *Hungary*, the leaves of the trees are often found of a golden colour, proceeding from the metalline exhalations of the mines; which, one would think, muſt, by reaſon of their weight, require a conſiderable heat to raiſe them into the open air.

Theſe latent fires and heats in the bowels of the earth will, it may be ſaid, account for the warmth only of thoſe places that are within reach of the action of ſuch efficients, which are, probably, wanting in many parts of the earth.

But the troubleſome degree of heat, to be found in ſome places of the third region, ſeems not always to be derivable from the two cauſes already aſſigned; which muſt, to produce ſo conſiderable an effect, be aſſiſted by a third, more powerful than themſelves; and this ſeems to be the incaleſcence there is, in many mines and other places, produced by the mutual action of the componant parts of immature and more looſely contex'd minerals, promoted by water; and eſpecially ſuch as are of a marcaſitical nature.

That ſuch an incaleſcence may be thus produced in the bowels of the earth, appears by example of the like, producible in mineral bodies above ground. And that marcaſites, which, for the moſt part, abound in vitriol, are bodies very fit to afford this ſubterraneal heat, may be confirmed by the ſulphureous and ſaline parts they contain; and by being many of them eaſily wrought on, both by ſimple water, and even by the moiſt air. And a gentleman, who went to viſit one of the deeper *Hungarian* mines, aſſured me, that in the lower parts of the mine, he gathered vitriol, which appeared above-ground to be of a golden nature; and that in a cave on one ſide of the groove, in the deep gold-mine near *Cremnitz*, the corroſive ſmell is ſo ſtrong and noxious, that men dare not dig out the rich metal it abounds with; being deterr'd by the ill fate of ſeveral, who ventured to work in it. He further told me, that tho' he paſs'd by it in great haſt, yet he was offended by the noiſom exhalations: and laſtly, that in gathering this vitriol deep under ground, he found ſome of it ſoft; but that when he had brought it into the open air, it harden'd, and appeared to have ſeveral golden ſtreaks in it.

I muſt not here omit, that the diggers in mines having found, by ſad experience, that in deep grooves, the air, unleſs renewed, does, in a ſhort time, become unfit for reſpiration; have been obliged to ſink, at ſome convenient diſtance from the groove, where the miners work, another pit, that uſually tends directly downwards; to which our *Engliſh* miners, in ſeveral parts of this kingdom, give different names; but 'tis call'd in the lead-mines of *Derbyſhire*, an air-ſhaft; where it is made 40, 50, and ſometimes 80, or 100 paces off, and as deep as the groove. From this air-ſhaft to the groove, wherein the men work, there paſſes a channel, to convey the air from the former to the latter; which is what *Agricola* ſometimes calls *Cuniculus*, and which, in the above-mentioned lead-mines, is called a drift; becauſe the air uſually, in the form of wind, drives thro' it, and thereby enables the workmen to breathe freely at the very bottom of the pit. And a very obſerving man, who much frequented theſe mines, told me, that at the depth of about 200 yards, he found, by the means of the air-ſhaft, that the air was very commodious for reſpiration; and alſo temperate as to heat and cold. But *Agricola* gives an odd account of the courſe of the air in the ſhaft and the pit; aſſerting it to come "from the upper to the lower, in the ſpring and ſummer "ſeaſons; and the contrary way in autumn, and the winter: he adds, that "the air, before its uſual courſe comes to be durably "ſettled, is, for the ſpace of a fortnight, liable to frequent changes; "ſometimes flying into the upper or higher groove, or drift; and "ſometimes into the lower, and paſſing out at the other."

If this obſervation conſtantly holds, it may hint ſome odd inquiries about conſiderable periodical changes in the ſubterraneal part of the earth, or in the air, or both; which have not yet been regarded. Tho' I muſt own, that a very obſerving perſon, who had the chief hand in contriving the ſubterraneal ſtructures in ſome deep lead-mines, aſſured me, that both winter and ſummer, the current of air went conſtantly the ſame way; the air entering in at the mouth of the air-ſhaft, and coming out at the perpendicular groove. And *Morinus* tells us, that in the deep *Hungarian* mines he viſited, the outward air paſs'd firſt thro' the burrows, and ſo thro' by-ways, that tended not directly downwards, but reached, at length, to the bottom of the perpendicular groove; whence, together with the ſteams, proceeding from the mine, it aſcended ſtrait upwards; without taking notice of *Agricola*'s obſervation, about the different courſe of the ſubterraneal air, at different ſeaſons of the year.

But theſe accounts are accommodated only to the few informations I have hitherto procured; and are therefore only propos'd to be rectified, or confirmed, by future obſervations.

In the mean time, we may gather from the whole, that tho' in ſome mines three ſubterraneal regions, with their diſtinguiſhing properties, are not inconveniently aſſignable; yet, generally ſpeaking, in the whole body of the terreſtrial globe, as far as we know it, both the bounds, and the temperature of the regions of the earth, as well as thoſe of the air, are very various and uncertain.

And much leſs have we any certain knowledge of the temperature of the more central parts of the earth; in which, whether there be not a continued ſolidity, or great tracts of fluid matter; and whether different regions are to be diſtinguiſh'd, and what is their number, order, thickneſs, *&c.* we are wholly ignorant.

What we have diſcuſſed, belongs only to the temper of thoſe ſubterraneal parts, to which men have been enabled to reach by digging. 'Tis true indeed, that ſome mines, eſpecially in *Germany* and *Hungary*, are of a vaſt depth; yet the deepeſt of all the mines, that I have as yet read, or heard of, from any credible relator, is that which *Agricola* mentions to be at *Cotteberg*. But what proportion does this it ſelf, tho' it reach to above 3000 feet, bear to the whole depth of the terreſtrial globe, whoſe ſemi-diameter is more than 4000 miles?

SECT. II.

Two different regions below the ſurface of the ſea.

THO' the air and the earth have, as to temperature, been diſtinguiſhed into three regions; yet the informations I have hitherto met with, aſſign no more than two to the ſea: the former whereof may be ſuppoſed to reach from the ſuperficies of it, as far downwards as the manifeſt operation of the ſun-beams, or other cauſes of warmth, penetrate; from which, to the bottom of the ſea, the other region may be allowed to extend.

But according to this diviſion, the limits of the upper region will not be always conſtant; for in the torrid zone, and other hot climates, it muſt, *cæteris paribus*, be greater than in the frigid, and the temperate zones; in ſummer than in winter; and in hot weather than in cold; ſuppoſing in theſe caſes the heat to come from the ſun and the air; and not, as ſometimes it may, from ſubterraneal exhalations.

The ſame cauſes will, likewiſe, alter the temperature of this region. This temperature may, alſo, be chang'd in ſome few places by, at leaſt, two other cauſes; the one is, the different conſtitution of the ſoil that compoſes the ſhore; which may affect the neighbouring water, if it extraordinarily abound with nitre, marcaſites, or other ſubſtances, able to increaſe or leſſen the coldneſs of the water.

Another cauſe may be, the figure and ſituation of the leſs deep parts of the ſhore, which may, in ſome ſort, reverberate the heat that proceeds from the ſun; and upon ſuch an account, either add to the warmth, or allay the coldneſs that would otherwiſe be found in the neighbouring water. There may, indeed, be other exceptions to the rule; tho', perhaps, referable to the two caſes already mentioned. Thus M. *de Monts*, in his voyage to *New-France*, tells us, that "about "the 18*th* day of *June*, he found the ſea-water, during three days "ſpace, very warm; and that their wine, by the ſame heat, was "warm'd in the bottom of the ſhip; tho' the air was no hotter "than before." And, that "on the 21*ſt* of the ſame month, they "were, for two or three days, ſo encompaſſed with miſts and cold, "that they thought themſelves in the month of *January*; the water "of the ſea being extremely cold, which continued till they came "upon the bank."

The temperature of the lower region of the ſea is generally cold. For water, being in its moſt ordinary ſtate, a liquor, whoſe parts are more ſlowly agitated, than thoſe of mens organs of feeling, muſt be, upon that account, cold as to ſenſe; and conſequently, thoſe parts of the ſea, which are too remote to be ſenſibly agitated by the ſun-beams, or wrought upon by the warmth, which the air, and upper parts of the earth, may from other cauſes receive, ſhould feel cold to thoſe who deſcend into it; except in a few places, where the cold may be either expell'd, or allay'd by hot ſprings, or terreſtrial exhalations, flowing, or aſcending from the ſubjacent earth, or the lower parts of the ſhore, into the incumbent, or adjacent parts of the water.

Relations about the temperature of the ſea.

I ſhall now ſubjoin ſome relations I procured, from perſons who had occaſion to go down into the lower region of the ſea; or otherwiſe to take notice of its temperature, in very different regions of the world, and at very unequal depths.

A profeſs'd diver, ſeveral times complained to me, of the coldneſs of the deep water in the north ſea, which kept him from being able to ſtay in it ſo long, as he otherwiſe might. He added, that he conſtantly found the cold increaſe, the deeper he deſcended.

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An acquaintance of mine, who made a long ſtay in *North-America*, and who took pleaſure in ſwimming under water, told me, that tho' he ſcarce remember'd himſelf to have dived above two fathoms beneath the ſurface of the ſea; yet even at that ſmall depth, he obſerved the water to increaſe in coldneſs, proportionably to his deſcent: which argues, that tho' the ſun-beams often penetrate plentifully enough to carry light to a great depth under water; yet they do not always bring with them a ſenſible heat; and that, at leaſt in ſome places, the upper region of the ſea reaches but a little way.

A perſon of quality, who had been preſent at the coral-fiſhing upon the ſhore of *Africa*, and who was himſelf a diver, inform'd me, that tho' he had ſeldom deſcended above three or four fathoms, yet he found it ſo much colder than near the top of the water, that he could not well endure it; and that being let down to the bottom of the ſea in a great diving bell, tho' the water cou'd not come immediately to touch him, he found, when the bell came firſt to the ground, the air in it was very cold; tho', after he had ſtay'd a while there, his breath, and the ſteams of his body, made him very hot.

A famous commander, who had been upon the *African* coaſt, informed me, that, in the day-time, he there preſerved his wine in a tolerable temper, by keeping it at the bottom of the ſhip in ſand; but that in the mornings, he had it greatly cool'd, by ſinking his bottles over-night into the ſea, and letting them hang till morning, at twenty or thirty fathoms deep under water.

An intelligent gentleman, who ſailed far up the river *Gambra* in a ſmall frigat, aſſured me, that in the ſea, even of thoſe hot climates, wine may be preſerved cool, by letting down bottles in the evening, exactly ſtopp'd, to the depth of twelve or fourteen fathoms; whence being the next morning drawn up, they find it very freſh, if preſently drank; otherwiſe the heat of the air on the upper part of the water would quickly warm it.

I remember too, that a man of letters, who ſailed to the *Eaſt-Indies*, told me, 'twas the practice of his captain, and other perſons of note, whilſt they paſs the torrid zone, to keep their drink, whether wine, or water, cool, by letting it down in bottles to the depth of eighty, ninety, or ſometimes an hundred fathoms; and ſuffering it to ſtay there for a competent time; after which, they found it to be exceeding cool and refreſhing.

Laſtly, to ſatisfie my ſelf as far as I could, to how great a depth the coldneſs of the ſea reached; meeting with a curious traveller, who had been in ſeveral parts of the *Eaſt* and *Weſt-Indies*, I enquired of him, whether he had taken notice of any extraordinary deep ſoundings in the vaſter ſeas; to which he anſwer'd, that ſailing to the *Eaſt-Indies*, over a place on the other ſide of the line, that was ſuſpected to be very deep; they let down 400 fathom of line; and that the lead, which weigh'd about 30 or 35 pounds, thereby received ſo intenſe a degree of coldneſs, that he thought a maſs of ice could not have more vehemently affected his hands; and this obſervation was made in about the 35*th* degree of ſouth latitude.

Theſe are the chief relations I have hitherto been able to procure, about the temperature of the ſea; which, if they happen to be confirmed by others, we may thence conceive, that, with regard to temperature, thoſe two fluids, air and water, have this in common, that where their ſurfaces are contiguous, and in the neighbouring parts, they happen to be ſometimes cold, and ſometimes hot, as the particles they conſiſt of chance to be more or leſs agitated, by the variouſly reflected rays of the ſun, or other cauſes of heat; but that the parts of the air, called the ſecond region, and the lower region of the ſea, being more remote from the operation of thoſe cauſes, retain their natural or more undiſturbed temperature; which, as to us men, is a conſiderable degree of coldneſs: ſo that the regions of the water and the air ſeem to anſwer one another, but in an inverted order.

We may farther conclude from the preceding accounts, that the ſea-water is not the *ſummum frigidum.* And, indeed, tho' I have been able, ſeveral times, to produce ice in ſalt-water; yet I find not by any obſervation, that there has been ice met with, and generated at the bottom of the ſea; under which the earth has been found unfrozen by our divers, and appears to be ſoft at depths, exceedingly ſurpaſſing the greateſt they have reach'd to; as is evident by the mud, gravel, *&c.* fetch'd from the bottom of the ſea by ſounding-plummets, let down to above an hundred fathoms. And a ſober commander of a ſhip, lately arrived from the remoter parts of the great ocean, informed me, that at about 35° ſouth latitude, the tallow of his ſounding-lead brought up grey ſand from 220 fathoms deep. But we cannot conclude, becauſe no ice is found at the bottom of the ſea, that the cold there cannot be very intenſe; for as the ſea is, at leaſt equally ſalt at the bottom, as at the top, ſo I have more than once try'd, that ſalt-water will, without freezing, admit a much greater degree of cold, than is neceſſary to turn freſh water into ice.

Relations about the bottom of the ſea.

One of the chief things I have been ſollicitous to inquire after, as to the bottom of the ſea, was the inequality I ſuppoſed to be in the ſoil; of which I received the following accounts.

The inequality of its floor.

A perſon, who had been at the famous pearl-fiſhing, in the little iſland of *Manar*, near *Ceylon*, in the *Eaſt-Indies*; and had by his ſtay there, great opportunity to ſee divers at their work, and converſe with them; aſſured me, he there learn'd, that the floor of the ſea was in many places exceedingly unequal; being here flat, and there craggy; rocks riſing to a conſiderable height in ſome parts; and valleys ſinking as deep in others; in which they found it exceſſive cold.

An ancient commander, who had for many years frequented *Africa*, and the *Indies*, told me, as others had done before, that when they ſailed in the ocean, very far from land, they ſeldom ſounded; but as far as they had, he uſually found the depth of the ſea to increaſe or decreaſe gradually, without very great irregularities, excepting in ſome places; inſtancing particularly, in the hollow that makes the bottom of the ſea within ſight of the cape of *Good-Hope*; where, tho' for the moſt part, he found the water to grow deeper as he ſailed farther from the ſhore; yet, in one place, he and others had met with a bank at a conſiderable diſtance from the ſurface of the water; ſo that tho' when they were, as they imagined, near the edge of this bank, they found but a moderate number of fathoms; yet when ſailing a very little way farther, they had gone beyond it, the ſea prov'd of an immenſe depth. In ſhort, I gather'd from his anſwers, that in the greater ſeas he had found, for the moſt part, the ground, at the bottom, to fall away by degrees; but nearer the ſhore, he obſerved, in ſeveral places, that it was very unequal, and had, as it were, hills and precipices.

A man of learning, who had ſail'd both to the eaſt and weſt *Indies*, and had made ſome of his voyages in ſhips of ſuch great burthen, as obliged the mariners to be frequent and careful in ſounding, informed me, that, ſometimes, at conſiderable diſtances from ſhore, he had obſerv'd the ſea to be twenty, thirty, or, perhaps, forty fathoms deeper when they caſt the lead from one ſide of the ſhip, than it had been juſt before, when they ſounded from the other.

In the notes of a very ſkilful pilot, lately arrived from the eaſt *Indies*, I found the following obſervations: "*Feb.* 12. Seeing the ground "under us, we heav'd the lead, and had but nineteen fathoms, rocky "ground, then hal'd by N. N. E. the wind at N. W. and found our "water to ſhoal from nineteen to ten and eight fathom, hard coral "ground; then it ſuddenly deepen'd again from eight to twenty and "twenty two fathoms, ſandy ground; and then we ſuddenly ſaw rocks "under us, where we had but ſeven fathom, and the next caſt fourteen "fathom again. And ſo having run N. N. E. from ſix in the morning "till twelve at noon, about nineteen miles, we deepen'd our water "from ſixteen to twenty five, and the next caſt no ground, with thirty five fathom of line."

Having met with an ancient navigator, who paſſes as the moſt experienc'd pilot in our nation for an *Eaſt-India* voyage, I aſk'd him about his own obſervations concerning theſe unequal ſoundings; and he told me, that he had not only met with them elſewhere; but that not far from the mouth of our channel, he had ſometimes found the bottom of the ſea ſo abrupt, that in ſailing twice the length of his ſhip, the water wou'd deepen from thirty to a hundred fathoms, if not much more.

And a noble perſon, who has, ſeveral times, had the command of the *Engliſh* fleet, informed me, that he had obſerv'd the bottom of the ſea to be exceeding unequal in neighbouring places; and that ſailing once, even in our channel, he perceiv'd the water to make a rippling noiſe, like that of the *Thames* under *London-bridge*, ſo that he was afraid they were falling upon ſome ſhoal; the water being twelve or fourteen fathoms deep; and going a little further, he caſt out the plummet again, and found it about thirty fathoms. He added, that he had made many ſuch obſervations, but took notice of rippling water only when the tide was ebbing; yet in a deep ſea, meeting with the like in the upper part of the water, and thinking it improbable there ſhould be any ſhoal there, he order'd the depth to be ſounded, and found it to exceed thirty fathoms; and after he had paſs'd on a little further, the ſea was ſo deep, that he could not fathom it with his ordinary line.

The preſſure at the bottom of the ſea.

Another thing obſervable, at the bottom of the ſea, is, the great preſſure of the water there againſt other bodies. But for a manifeſt proof of this, we caus'd a cylindrical glaſs, that was open only at one end, to be ſo depreſſed in a glaſs-veſſel full of water, with a convenient weight of lead, that none of the air cou'd get out; whilſt we eaſily diſcern'd thro' the liquor and veſſels, which were all tranſparent, that as the inverted cylinder deſcended deeper, the external water compreſs'd the impriſon'd air, and aſcended higher in the cavity of the cylinder; againſt whoſe ſides we had before-hand plac'd a row of marks, whereby to take notice of the gradual aſcent and deſcent of the internal water.

Having inquired of two ſeveral perſons, one whereof had, with a diving-engine, been at the bottom of the ſea in a cold northern region; the other having done the like, in an engine much of the ſame ſort, upon the coaſt of *Africa*; I found their relations to agree in this, that the deeper they deſcended into the ſea, the more the air, they carried down with them, was compreſſed; and the higher the water aſcended above the lip or brim of the engine into the cavity of it.

And an engineer of my acquaintance, who had been often at ſea, and lov'd to try concluſions, aſſured me, that having, ſeveral times, ſailed near the ſtreights mouth, over a place where the ſea was obſerved to be of a notable depth, he found, that if he let down with a weight, into the ſea, ſuch a vial as the ſea-men uſe to carry their brandy in, containing a pint or a quart, it wou'd, when it came to be ſunk forty fathoms under water, if not ſooner, be ſo oppreſs'd, as to be cruſh'd to pieces. He alſo averr'd, that having exactly clos'd a metalline æolipile, and with a competent weight ſunk it ſixty fathoms into the ſea; when he pull'd it up again, he found, that the great preſſure of the water had, in ſeveral places, cruſh'd it inwards.

The tranquillity of the water at great depths.

A third thing obſerved, at the bottom of the ſea, is, the tranquillity of the water, if it be conſiderably diſtant from the ſurface. For tho' the winds have power to produce vaſt waves in that upper part of the ſea, which is expos'd to their violence; yet the vehement agitation diminiſhes, by degrees, as the parts of the ſea lie more remote from the ſuperficies; ſo that towards the bottom, if that lie conſiderably deep, and far from ſhore, the water is ſcarce ſenſibly diſturb'd.

This calmneſs of the ſea will appear ſtrange to many, who, admiring at the force of ſtormy winds, and the vaſtneſs of the waves they raiſe, do not, at the ſame time, conſider the almoſt incomparably greater quantity and weight of water that muſt be mov'd, to make any great commotion at the bottom of the ſea; upon which ſo great a maſs of ſalt-water is conſtantly incumbent.

But a diver, who, by the help of an engine, could continue for ſome hours under water, inform'd me, that the wind being ſtrong, ſo that the waves were manifeſtly ſix or ſeven feet high above the ſurface of the water, he found no ſign of it fifteen fathoms deep; but that if the blaſts continu'd long, they then mov'd the mud at the bottom, and made the water thick and dark; and that ſtaying once at the bottom of a deep ſea very long, he was amaz'd, at his return to the upper parts of the water, to find a ſtorm there, which he dreamt not of; having left the ſurface calm when he deſcended.

A great traveller, who had aſſiſted at a rich pearl-fiſhing in *Eaſt-India*, told me, that he had ſeen the divers deſcend when the ſea was ſo very rough, that ſcarce any veſſel would venture out of port; yet thoſe returning divers aſſured him, that, at the bottom, they had found no diſturbance of the water; and, this tho' the ſituation render'd it exceeding likely to be a troubled ſea.

And a very eminent ſailor aſſured me, that having, ſometimes, been in great ſhips that drew much water, he had dived to the keel of them, when under ſail, and obſerved the agitations of the water to be exceedingly diminiſhed, even at that ſmall diſtance from the upper part of the waves; he added, that in *Amrica* he learn'd to dive of the *Indians*, who taught him, by their example, to creep along by the rocks and great ſtones, that lay near the ſhore, at the bottom of the water, who thus ſhelter themſelves from the ſtrokes and other ill effects of the billows, which, near the ſhore, when the ſea is ſhallow, often hurt and endanger ſwimmers and unskilful divers. But when they are, by this means, got farther from ſhore, and into deeper water, they will ſecurely leave the ſhelter they had, till then, made uſe of, and ſwim within a few yards of the ſurface of the ſea; fearing there no danger from the toſſings and commotions of the upper part of the water.

And farther, a great commander at ſea, who has both an extraordinary curioſity, and an unuſual care in making obſervations, informed me, that he had lately been at a place when the ſea was often tempeſtuous; and that they found, by a ſure mark, the ſtorm did not reach, with any efficacy, four fathoms beneath the ſurface of the water.

I have ſollicitouſly inquired, whether the tides reach to or near the bottom of the deeper ſeas; but found it exceeding difficult to obtain any ſatisfaction about a problem, that moſt navigators, I have convers'd with, ſeem not to have dream'd of.

Indeed, I have heard, of currents driving the ſounding line, at a great depth, with a brisk motion, contrary to that of the ſhip; and a skilful obſerver, who commanded many of our *Engliſh* men of war, own'd to me, that he had, near the *Sound*, obſerved the upper and lower parts of the water, to move, with a conſiderable ſwiftneſs, different ways.

But one of the moſt ancient and experienced pilots of our nation, aſſured me, that ſailing beyond the cape of *Good-Hope*, into the ſouth ſeas, he made trials of the motion of the upper parts of the water above the lower; where, ſometimes, caſting out a large heavy plummet, he let it down to ſeveral depths ſhort of 50 fathoms, without any ſenſible operation upon the motion of the boat he ſtood in; but when he ſunk his plummet lower, to about 100 fathoms; he then found, that tho' it reached not to the bottom of the water, yet his boat turned towards the tide or current, as if it lay at anchor; the water running by the ſide of the boat at the rate of three miles an hour.

And one, who ſpent ſome time at a famous *Eaſtern* pearl-fiſhing, told me, the divers affirmed to him, that ſometimes at the bottom of the deep waters, there ſeemed to be a ſtagnation of the ſea; ſo that they would, to a particular height, riſe directly upwards; but that at other heights, they were carried away by the ſhallower waters, ſo as to be found, when they emerged a great way off, from the point of the ſurface, perpendicular to that part whence they began to aſcend.

Laſtly, a learned merchant ſent me the following account, of an extraordinary in-draught of the ſea, on the coaſt of a great iſland of the ſouthern ocean. "At *Campar* and *Rakan*, on the eaſt coaſt of "*Sumatra*, is in the river's mouth, to a certain diſtance, at each new "and full moon, a violent in-draught of the ſea, called *Bunna*, which "approaches with an hideous noiſe, and mountain high; ſo that what-"ever oppoſes it periſheth. Its approach is in three parts, the firſt "high, but not ſo terrible; the ſecond high, black, and horrid; the "third low, and of gentle motion. Before its approach, it gives ſo "fair warning, that the ſailors may eat, and bathe themſelves, before "they weigh anchor; but when they weigh, they muſt row hard "againſt it; and when its fury is paſt, follow with it, till they "return to their anchor-place. The true reaſon hereof the inhabi-"tants cannot diſcover. My opinion is, (adds my relator) that the "mouths of the rivers there, being choaked up with their ſand-"banks, and ſo render'd very ſhallow; when the great ſpring-tides "come rolling over thoſe ſhoals, at the new and full moon, out of "the *Malacca* ſtreights, the firſt influx is irreſiſtible by ſuch ſmall "veſſels as uſe that port; whence they are forced to weigh, and "bear up againſt it, for fear of being ſtranded or ſplit."

The laſt obſervable I ſhall mention is, the growth of plants at the bottom of the ſea.

Plants growing at the bottom of the ſea.

An eminent and inquiſitive perſon, who ſpent ſome time on the coaſt of *Africa*, where he was preſent at a coral-fiſhing, told me, he had found coral ſoft and flexible, but not truly red, when firſt brought up into the air; the bark being worſe coloured, than the ſubſtance it cover'd; but that when the bark was taken off, and the other part expos'd to the air, the redneſs diſclos'd it ſelf. When I demanded, whether he had obſerved any inky ſap aſcend, to nouriſh the ſtony plant; and whether he had ſeen any thing like berries upon it; he ingenuouſly confeſs'd to me, he had not been ſo curious as to make inquiry into thoſe particulars; but that having broken ſome of the large pieces, he took notice, that the more internal ſubſtance was much paler than the other, and very whitiſh; and that at the extreme parts of ſome branches, or ſprigs, he obſerved little blackiſh knobs; which he did not then know what to make of. But as to the depth of the ſea in that place, he ſaid, 'twas 9 or 10 fathoms.

And a gentleman, who ſailed much in the *Eaſt*, aſſured me, they often meet in thoſe ſeas, with a certain ſort of coral, not white, which bears a ſmall fruit like a round berry, of a pleaſant colour, and eſteem'd a rarity.

Asking a profeſs'd diver, whether he had not found trees, or fruit, in the depth of the ſea; he told me, that in a great ſhip whereinto he deſcended, to recover thence ſome ſhip-wreck'd goods, he was ſurpriz'd to find, in ſeveral places, a certain ſort of unknown fruit, of a ſlimy and ſoft conſiſtence, about the bigneſs of apples, but not ſo round in ſhape; which, when he brought up into the air, ſoon began to ſhrink like old rotten apples; but were much harder, and more ſhrivel'd. And 'tis remarkable, that this happen'd in a cold, northern ſea.

One who made a conſiderable ſtay about *Manar*, told me, he learn'd from the divers, that in ſome places thereabouts, there grows at the bottom, in plenty, a ſort of trees bearing leaves, almoſt like thoſe of laurel, as alſo a certain fruit.

I was, likewiſe, informed by an eye-witneſs, that near the coaſt of *Moſambique* in *Africa*, there grows at the bottom of the ſea, numerous trees, bearing fruit; which he deſcribes to be very like that which in *America* they call *Acayu*; the leaves alſo reſembling thoſe of that tree.

But the moſt acceptable information I could procure about ſubmarine plants, is that which concerns the famous *Maldivian*, or *Cocoa* nut, ſo highly eſteemed in the *Eaſt*, that, as ſome write, it is a great preſent from one king to another; and is beſides greatly commended in *Europe* by phyſicians; for, the origin of this dear drug

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is almoſt as much controverted, as its alexiterial virtues are extoll'd.

A man of learning, who had reſided upon the ſpot, told me, he often heard from the divers, that there are real nuts or fruit, bore by a ſort of cocoa-trees growing at the bottom of the ſea; and that they are thence either torn off by the agitation of the water, or gather'd by the divers. This fruit is ſmaller than moſt other ſorts of cocoa's, whoſe maturity they do not ſeem to arrive at. He thinks the ſpecies may have been very different from what it is; and have come from nuts fallen into the ſea; together with the ruin of ſome little iſlands undermined by the water, and ſo drowned: of which, he told me, he ſaw three or four inſtances, during his ſtay there. He added, that whilſt the fruit was under water, they obſerved no diſtinct ſhell and kernel; but the entire nut was ſo ſoft, that it might be eaſily cut with a knife, and was eaten like their other fruits; that being kept, for about a week, in the hot air, it grows ſolid and ſo hard, as to require ſteel tools to work upon it; and laſtly, that tho' even upon the place, the fairer ſort be of very great eſteem, yet there are none of ſuch prodigious price as is given out. He preſented me with one, about the bigneſs of a large egg, and a fragment of another; which are both very hard. *

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* Count *Marſigli* has, from his own experience, wrote a very voluminous, phyſical eſſay, upon the natural hiſtory of the ſea; and therein occur abundance of curious particulars, relating to this ſubject: ſome ſketches whereof M. *Fontanelle* gives us in his hiſtory of the Royal Academy, for the year 1710.

CHYMISTRY.

THE

PREFACE.

THE great advantages of chymiſtry, and its exceeding uſefulneſs both to philoſophy and medicine, ſeem to be very little known, or conſidered, by the generality of mankind.

For this reaſon, and becauſe Mr. Boyle *has been cenſured by ſome learned men, for cultivating an art which they apprehended to be unworthy of him, I would willingly offer ſomething, from others, towards the clearing of this matter, and wiping off an aſperſion, which, thro' a falſe notion of chymiſtry, has been caſt upon our excellent author.*

We are to obſerve, with an eminent writer, that "chymiſts may be divided into three ranks: ſuch as look after the knowledge of nature in general; ſuch as ſeek out and prepare medicines; and ſuch as ſearch after riches, by tranſmutations, and the great elixir. The two firſt, ſays that learned prelate, have been very ſucceſsful in ſeparating, compounding, and changing the part of things; and in ſhewing the admirable powers of nature, in the raiſing of new conſiſtences, figures, colours, and virtues of bodies: and from their labours, the true philoſophy is like to receive the nobleſt improvements. But the pretenſions of the third kind are not only to endow us with the benefits of this life, but with immortality it ſelf; and their ſucceſs has been as ſmall as their deſign was extravagant; —— but certainly, if they cou'd

“ *be brought to content themſelves with moderate things; to*
“ *grow rich by degrees; and not to imagin they ſhall gain the*
“ Indies *out of every crucible; there might be wonderful things*
“ *expected from them. And of this we have good aſſurance by*
“ *what is come abroad from divers eminent perſons; among*
“ *whom ſome are members of the Royal Society. And if it were*
“ *not already excellently perform'd, I might ſpeak largely of*
“ *the advantages that accrue to phyſic, by the induſtrious la-*
“ *bour of ſuch chymiſts, as have only the diſcreet and ſober*
“ *flame; and not the wild lightning of the others brains.*” *

Of the art, as 'tis purſued by the third kind of chymiſts, I ſhall here take no notice; but only as 'tis happily practiſed by the other two.

The office of chymiſtry is, by the application of fire, to ſeparate the parts of natural bodies into diſtinct parcels; and, by means of the ſame agent, to unite the parts of others into one whole. This is, nearly, the definition of that judicious chymiſt, M. Homberg.

Now the operations of chymiſtry being generally perform'd in tranſparent veſſels, upon known bodies, by known efficients, it is an art that, at firſt ſight, bids fair for improving both phyſic and philoſophy; ſince it eaſily preſents us with a great variety of reſolutions and compoſitions; and ſhews us the ſeveral ſteps that are taken to produce them. There are numberleſs bodies in nature, which the fire actually divides into ſeveral parts, according to their different degrees of volatility, gravity, or attraction; and unites others, as the texture, figure, and the attractive power of their parts determine. Hence, therefore, we have an opportunity of viewing nature, either in a more ſimple, or a more complex ſtate than that wherein ſhe, of her ſelf, appears. And this muſt neceſſarily lead to ſome diſcovery of the properties of different bodies; whereby philoſophy will be improved: and as the different parts, and different combinations of animal, mineral, and vegetable ſubſtances, have different medicinal virtues; phyſic will, by this means, receive improvement alſo.

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* Dr. *Sprat*'s Hiſt. of the Royal Society. *p.* 37.

“ *The beſt way of explaining nature, ſays M.* Fontanelle, “ *is to imitate her, and make her, by art, produce the ſame* “ *effects from known cauſes, which we our ſelves can put* “ *in action. By this means we become witneſſes of the* “ *phenomena, and the ſeveral ſteps taken to produce them;* “ *and may, if the analogy be juſt, ſafely conclude, that the* “ *natural phenomena have the ſame origin with the artificial.*”

But no art can ſo well as chymiſtry, imitate the more abſtruſe and hidden operations, and phenomena of nature. Thus by familiar and obvious examples, it ſhews us how lightning, and the Aurora borealis, *are producible; theſe being exquiſitely reſembled by* Phoſphorus: *by ſome eaſy experiments of ſublimation and precipitation, it ſhews how the odd effects of the plague may be ſuddenly produced and ſtopt; and it accounts for many other ſtrange phenomena, which ſeem inexplicable by any other means than what this art affords.*

'Tis well obſerved by the learned Boerhaave, *that* “ *all the* “ *changes which a body undergoes, are made by motion; and* “ *therefore, ſays he, we muſt ſearch into its cauſes, and learn* “ *the manner whereby it may be excited, changed, and ſtopp'd.* “ *But theſe powers lie out of the reach of the human mind;* “ *unleſs from the obſervation of evident effects, they firſt* “ *appear to the ſenſes.*” “ *We cannot, therefore, do better,* “ *continues he,* “ *than to fix our eyes upon thoſe motions, which* “ *ariſe when bodies begin to act contiguous to others. Now, to* “ *apply one body to another, again to ſeparate them, and by* “ *the force of fire to give them their proper motion, muſt* “ *be a moſt effectual means to gain the knowledge of the* “ *powers of bodies. And this is the whole office of chymiſtry,* “ *which muſt, therefore, be an excellent inſtrument in the* “ *hands of a philoſopher, who knows how to apply it; and* “ *the beſt that is known to reveal the ſecrets of nature.*”*

Chymiſtry, indeed, has been wretchedly abuſed; and great maſters in the art, have ſtrain'd and applied it to purpoſes for which it ſeem'd never deſign'd.

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* Boerhaave in Serm. Acad. de Chemiâ ſuos errores expurgant. A. 1718. p. 15.

The general fault committed herein, was, that from a few caſual experiments, they would needs account for all the diſeaſes in the human body, all the phenomena of nature, and all the myſteries of religion: for chymiſtry has had its enthuſiaſts. And doubtleſs, as managed by them, it has been the occaſion of much miſchief in the world.

Theſe errors, however, are not to be attributed to the art, but to the artiſts. And if ſome chymiſts have introduced errors into this art, they are happily expunged by others; as the diligent Boerhaave, *in a ſet diſcourſe, has abundantly proved.**

In ſhort, chymiſtry is another thing than what it formerly was; it has now made ample amends for all the darkneſs and obſcurity wherein it formerly involved the world. Their's were the clouds and ſmoke, but ours the flame and the light.

Let any man compare the Prælectiones Chymicæ *of Dr.*Freind, *with the common* Tyrocinia *of chymical writers; the treatiſes of M.* Homberg, *with thoſe of* Tachenius; *and the chymical pieces of Mr.* Boyle, *with thoſe of* Helmont; *and he will be ſenſible of this difference.* †

Who can read the accounts, which Meſſieurs Homberg, Lemery, *and the illuſtrious* Newton, *give of the action of the ſun, and of fire, upon bodies, without being ſurpriz'd and delighted, at the proſpect it opens; and at the great length whereto, on ſolid and experimental grounds, it carries us in philoſophy? Theſe great men evidently demonſtrate, that fire is a grand, and an active principle in nature; that daſhing againſt bodies, 'tis abſorbed by them; that lodging it ſelf therein, it becomes the cauſe of all the light they give us; and that were it not for this admiſſion of its rays, our fluids would be ſolids, and our water ice.*

M. Homberg *ſhews, that the rays of the ſun exerciſe an actual force, or truſion; for he found, that a very light body,*

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* Serm. Academ. de Chemià.

† Qui *Hombergiana Tachenio, Helmontio Boyleana*; qui vulgatos tirociniorum ſcriptores contulerit cum iis quæ in miſcellaneis *Germanorum*, in monumentis *Gallicis*, in *Britannicis* jam habentur commentariis, prudens ferat judicium; nec juſtum hujus calculum reformidabo. *Boerhaave* in Serm. Acad. de Chem. p. 21.

expoſed to the focus of a burning-glaſs, would be turned over upon the matter whereon 'twas laid; and that the rays, thrown, by ſtarts, thro' a ſmall lens, upon the ſpring of a watch, ſtraiten'd and ſtuck with one end into a board, made it vibrate; as if it had been puſh'd with a ſtick. ||

“*The ſun, ſays M.* Lemery, *may be conſidered as the grand reſervatory of luminous matter; and all inflammable bodies, as little reſervatories ſubſervient to him; that, as ſo many little ſuns, occaſionally ſupply our neceſſities.*”

M. Homberg *farther ſhews us, that* “*the light of the ſun impinging againſt terreſtrial bodies, modifies them according to their ſeveral textures: thus ſome, as water, it eaſily keeps fluid; of others, it forms oily, unctuous bodies; and makes inflammable ſubſtances of ſalts, of earth, and of water; none of which are, of themſelves, inflammable; ſo that the other chymical principles of bodies, ſerve chiefly to detain this, or to be changed by its actions upon them.*” “*The luminous matter,*” *according to the ſame excellent chymiſt,* “*inſinuates it ſelf into the ſubſtance of bodies, to produce their ſulphur; changes the arrangement of their parts; increaſes them, and, by conſequence, alters the ſubſtance of the body it ſelf, after as many different manners, as in different quantities it can be differently placed; whence proceeds an infinite variety. So that, would we compare the variety of the materials which exiſt, with thoſe which might be brought into being, by all the combinations poſſible to be made; we muſt ſay, that the univerſe, ſo far as we know of it, is but very ſmall, in compariſon of what it might be; and that, if there were ſeveral worlds, formed like this of ours, they might all be differently furniſhed with objects, without changing either the manner, or the matter of the bodies, whereof they ſhould conſiſt: which demonſtrates an infinite contrivance and power in the Being who made the univerſe.*”

And a ſtill greater philoſopher, prompted by chymical experiments, demands, whether “*groſs bodies, and light, are not*

|| Hiſt. de l'Acad. A. 1708. p. 25.

But if any one ſhall ſtill retain a doubt of the worth and abilities of chymiſtry, to reward thoſe who cultivate it; let him conſider the practice and procedure of the happieſt philoſopher the world ever yet cou'd boaſt, the great Sir Iſaac Newton; *who, when he demonſtrates the laws, the actions, and the powers of bodies, from a conſideration of their effects, always produces chymical experiments for his vouchers; and when, to ſolve other phenomena, he makes uſe of theſe powers, his refuge is to chymiſtry; whence he manifeſtly ſhews, that without the aſſiſtance of this art, even he cou'd hardly have explained the peculiar nature and properties of particular bodies.* *

That chymiſtry has furniſhed the ſhops with many excellent preparations, and ſuch as have ſeveral advantages over the common Galenic *remedies, is now too generally allow'd, to need that particular examples ſhou'd be produc'd of it. That this art, alſo, meliorates ſeveral metalline and mineral bodies, and ſupplies many ſubſtances, uſeful in particular trades, and in ſeveral occurrences of human life, is a matter of fact acknowledg'd by all who are acquainted with the art, and its productions; ſo that it were time miſpent, by an induction of more particulars, to ſhew its uſefulneſs to mankind, both in philoſophy and phyſic.*

'Tis evident, therefore, that nothing but an intire ignorance of chymiſtry can cauſe it to be ill ſpoken of; and that it is ſo far from being an employment unworthy of a gentleman and a philoſopher; that it is one of the principal whereto he ought to addict himſelf, who wou'd improve either philoſophy or phyſic. †

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* Deſino igitur ſed in eo, in quo ultimam perſpicientiæ humanæ metam poſuiſſe videtur natura, *Iſaaco Newtono.* Ille, licet adeo felix ut cum vivente de principatu in philoſophiâ contendat nemo ſanus, quando leges, actiones, vires corporum ex perpenſis demonſtrat effectis, non aliud quam chemiam allegat; quando inventas ibi vires iterum extricandis applicat phænomenis, mera chemica advocat, claroque teſtatur exemplo, abſuiſſet chemia, ſingularium corporum propriam indolem, proprias vires, vix potuiſſe mortalium perſpicaciſſimo cognoſci. *Boerhaav. Serm. Acad. de Chemiâ*, *p.* 39, 40.

† In phyſicis nil deſperandum hàc (i. e. chemià) duce; omnia bona ab hàc ſperanda in medicis; abditiſſima revelare, extricare impedita, latentes corporum vires detegere, imitari, dirigere, mutare, applicare, perficere, docet fideliſſimè. *Boerhaav. Serm. de Chem. p.* 38, 39.

THE SCEPTICAL CHYMIST:

OR,

CONSIDERATIONS

UPON THE

Experiments uſually produced in favour of the four elements, and the three chymical principles of mixed bodies.

SECT. I.

NOtwithſtanding the ſubtile reaſonings of the *Peripatetics*, and the pretty experiments of the chymiſts, I am ſo diffident as to think, that if neither can produce more cogent arguments, for the truth of their aſſertion, than are uſually given ; a man may reaſonably doubt as to the number of thoſe material ingredients of mixed bodies, which ſome call elements, and others principles.

The number of the Peripatetic *elements, and chymical principles doubtful.*

Indeed, when I conſider'd, that theſe principles are as eſſential in natural philoſophy, as the real elements themſelves are in the univerſe ; I expected to find them ſolidly eſtabliſhed. But upon impartially examining the bodies themſelves, which are ſaid to reſult from the blended elements ; and torturing them into a confeſſion of their conſtituent principles ; I was quickly induc'd to think, that the number of them had been contended for with more earneſtneſs than ſucceſs.

The words element, and principle, are here uſed as equivalent terms ; and ſignify thoſe primitive and ſimple bodies, of which the mix'd ones are ſaid to be compos'd ; and into which they are ultimately reſolv'd.

Elements and principles, what?

'Tis

Arguments for the four elements

'Tis ſaid, that a piece of green wood, by burning, diſcovers the four elements of which mixed bodies are compoſed : the fire appearing in the flame, by its own light ; the ſmoak aſcending, and readily turning into air, as a river mixes with the ſea ; the water, in its own form, boiling out at the ends of the ſtick ; and the aſhes remaining for the element of earth.

This doctrine of the four elements is, alſo, ſaid to have been deliver'd by *Ariſtotle*, as the reſult of his ſtudy and application, in comparing the theories of the former philoſophers ; and that it has, ever ſince, been univerſally embraced by men of learning, till *Paracelſus*, and a few other chymiſts, deny'd it, and aſſerted only three principles, which they endeavoured to diſguize by the terms, ſalt, ſulphur, and mercury.*

Conſidered.

But by this experiment it ſhou'd appear, that the elements are made of mix'd bodies, rather than mix'd bodies of the elements. For in wood, thus analyz'd, and other bodies diſſipated and alter'd by the fire, it appears, that the ſuppoſed elementary fire and water are made out of the concrete ; not that the concrete was made up of fire and water. And, it has never, that I know of, been prov'd, that nothing can be obtained by committing a body to the fire, that was not pre-exiſtent in the body.

'Tis true, when a refiner, mixing gold and lead, expoſes them upon the cupel to a violent fire ; he thereby ſeparates the mixture into its component ingredients, gold, and lead, which, driven off with the droſs of the nobler metal, makes litharge of gold.

But then we do not ſee nature pull down a parcel of the element of fire from, where 'tis fancied to be plac'd, near the orb of the moon, and blend it with a quantity of each of the three other elements, to compoſe every mix'd body ; as we ſee the refiner take both gold and lead to compoſe the maſs we ſpeak of. Beſides, it remains to be proved, that the fire only takes the elementary ingredients aſunder, without cauſing any other alteration ; for otherwiſe, bodies may afford ſubſtances which were not pre-exiſtent in them ; as fleſh, too long kept, produces maggots, *&c.* Now that the fire does not always barely ſeparate the elementary parts, but, ſometimes at leaſt, alters the ingredients of bodies, appears probable from the inſtance given; wherein there is nothing elementary ſeparated, by the great violence of the refiner's fire: the gold and lead, which are the two ingredients ſeparated by the analyſis, being yet perfectly mix'd bodies; and the litharge being lead indeed, but ſuch as is different in conſiſtence, and other qualities, from what it was before. And I have, ſometimes, ſeen parcels of glaſs adhering to the teſt, or cupel; which proceeding, as well as the gold or litharge, from the analyſis, is not, ſurely, a third ingredient produced out of the maſs by the fire.

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* The judicious M. *Homberg*, who has greatly improved the art of chymiſtry, or rather, advanced a new one, gives us the following account of the three chymical principles. The ſaline principle is, according to him, a matter ſoluble in water, and unreſolvable by the fire ; being the acid ſubſtance, and general baſis of all ſalts ; tho' never to be found in a pure and unmixed ſtate.

This author, by numerous experiments, made with the utmoſt care, cou'd never obtain any ſulphureous principle from bodies; and brings ſeveral arguments to prove, that ſuch a principle is, in reality, fire or light, ſtriking againſt, reſiding in, and acting upon bodies.

The principle, mercury, is, according to the ſame candid chymiſt, a real quick-ſilver, or liquid ſubſtance, perfectly reſembling a fluid metal ; being nearly of the ſame weight with ſilver, and wetting nothing but metals. See *French Memoirs*, *A.* 1702. *p* 4. *A.* 1705. *p.* 117. *A.* 1708. *p.* 404. *A.* 1709. *p.* 133.

But, there are many bodies, from whence it ſeems impoſſible to extract four elements by fire: and which of them can be obtained from gold, by any degree of fire whatſoever? Nor is gold the only body in nature, that would puzzle a bare *Ariſtotelian* to analyze, by the fire, into elementary bodies: for ought I have yet obſerv'd, ſilver calcin'd, *Venetian* talc, *&c.* are ſo fixed, that to reduce any of them into four heterogeneous ſubſtances, has hitherto prov'd a task much too hard even for chymiſts.

And as there are ſeveral bodies, not reducible, by fire, into ſo many as four heterogeneous ingredients; ſo, there are others which may be reduced into more: human blood, and that of other animals, yield five diſtinct ſubſtances; phlegm, ſpirit, oil, ſalt, and earth; as experience teſtifies.

The matter of all bodies originally divided into ſmall particles, of different ſhapes and ſizes.

To proceed farther; it ſeems probable, that at the firſt production of mixed bodies, the univerſal matter, whereof they conſiſt, was actually divided into little particles of ſeveral ſizes and ſhapes, variouſly mov'd.

Beſides what happens in the generation, corruption, nutrition, and decreaſe of bodies; microſcopes, by diſcovering the extreme minuteneſs of the ſcarce ſenſible parts of concretes; chymical reſolutions of mixed bodies, and many other operations of fire upon them, ſeem ſufficiently to manifeſt, that they conſiſt of parts very minute, and of different figures: and that there alſo intervenes a various local motion of ſuch ſmall bodies, will ſcarce be denied; whether we grant the origin of matter aſſigned by *Epicurus*, or that related by *Moſes*. For, the firſt ſuppoſes, both mixed bodies, and all others, to be produced by the various, caſual occurſions of atoms, moving themſelves, every way, by an internal principle, in the infinite *Vacuum*. And the inſpired hiſtorian informs us, that the great and wiſe author of things, did not immediately create plants, beaſts, birds, *&c.* but produced them out of thoſe portions of the pre-exiſtent created matter, which he calls water and earth; and allows us to conceive, that the conſtituent particles, whereof theſe new concretes were to conſiſt, muſt have been variouſly moved, in order to be connected into the bodies they were, by their various coalitions and textures, to compoſe.

Theſe particles might unite into ſmall maſſes not eaſily ſeparable again.

'Tis alſo poſſible, that of theſe minute particles, many of the ſmalleſt and contiguous ones aſſociated into minute maſſes; and by their coalitions, conſtituted ſuch numerous, little, primary concretions, as were not eaſily ſeparable into the particles that compoſed them.

Gold will mix and fuſe, not only with ſilver, copper, tin, and lead; but with antimony, *Regulus Martis*, and many other minerals; and thereby compoſe bodies, very different both from gold, and the other ingredients of the reſulting concretes. The ſame gold may alſo, by common *Aqua regia*, and ſeveral other menſtrua, be reduc'd into a ſeeming liquor; ſo that the corpuſcles of the metal will, with thoſe of the menſtrua, paſs thro' paper; and with them coagulate into a cryſtalline ſalt. And further, with a ſmall quantity of a certain ſaline ſubſtance, I can eaſily ſublime gold into the form of long cryſtals: and by many other ways may gold be diſguiz'd, and help to conſtitute bodies of very different natures, both from it ſelf, and from one another; yet be afterwards reduced to the ſame numerical, yellow, fixed, ponderous, malleable ſubſtance, it was before its mixture. And not only the moſt fixed, but alſo the moſt fugitive of metals, conſpires to favour our aſſertion; for quick-ſilver will, with ſeveral metals, compoſe an amalgam; with ſeveral menſtrua, it ſeems to be turned into a liquor; with *Aqua fortis*, it will be brought into either a red, or a white precipitate; with oil of vitriol, into one of a pale yellow; with ſulphur, it will compoſe a blood-red volatile cinnabar; with ſome ſaline bodies, it will aſcend in form of a ſalt, diſſoluble in water; with *Regulus* of antimony, and ſilver, I have ſeen it ſublim'd into a kind of cryſtals; with another mixture, I reduced it into a malleable body; and into a hard brittle ſubſtance by another: and ſome there are, who affirm, that by proper additions, they can reduce quick-ſilver into an oil; nay, into glaſs; yet out of all theſe compounds, we may recover the very ſame running mercury, that was the principal diſguiz'd ingredient of them. Hence it appears not abſurd to conceive, that little primary maſſes, or cluſters, may remain undiſſipated, notwithſtanding they enter the compoſition of various concretions; ſince the corpuſcles of gold and mercury, tho' not primary concretions of the moſt minute particles of matter, but confeſſedly mix'd bodies, are able, plentifully, to concur to the compoſition of ſeveral very different bodies, without loſing their own nature, or texture, or having their coheſion violated by the loſs of their aſſociated parts, or ingredients.*

And

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* Concerning the nature, and various forms of bodies, and the ſulphur they contain, take the words of one, who ſeems thoroughly to have conſider'd them. " Altho' a pſeudo-topaz, ſays " Sir *Iſ. Newton*, a *Selenites*, rock-cryſtal, " iſland-cryſtal, vulgar glaſs, (that is, " ſand melted together,) and glaſs of antimony; which are terreſtrial, ſtony, " alcalizate concretes; and air, which, " probably, ariſes from ſuch ſubſtances " by fermentation; be ſubſtances very " differing from one another in denſity; yet they have their refractive " powers almoſt in the ſame proportion to one another, as their denſities; " except-

A great variety of compounds may ariſe from a few ingredients.

And as confidently as ſome chymiſts, *&c.* object againſt the *Peripatetics*, that from the mixture of their four elements, there could ariſe but an inconſiderable variety of compound bodies; yet if the *Ariſtotelians* were half ſo well vers'd in the works of nature, as in the writings of their maſter, this objection would not triumph for want of experiments to ſhew the contrary. For if we aſſign to the corpuſcles, whereof each element conſiſts, a peculiar ſize and ſhape,

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"excepting that the refraction of that ſtrange ſubſtance, iſland-cryſtal, is a little bigger than the reſt. And particularly air, which is 3500 times rarer than the pſeudo-topaz, and 4400 times rarer than glaſs of antimony, and 2000 times rarer than the ſelenites, glaſs vulgar, or cryſtal of the rock, has, notwithſtanding its rarity, the ſame refractive power in reſpect of its denſity, which thoſe very ſubſtances have with reſpect to theirs; excepting ſo far as thoſe differ from one another. Again; the refraction of camphire, oil-olive, linſeed-oil, ſpirit of turpentine and amber; which are fat, ſulphureous, unctuous bodies; and a diamond, which, probably, is an unctuous ſubſtance coagulated, have their refractive powers in proportion to one another, as their denſities, without any conſiderable variation. But the refractive powers of theſe unctuous ſubſtances are two or three times greater, in reſpect of their denſities, than the refractive powers of the former ſubſtances, in reſpect of theirs. Water has a refractive power in a middle degree, between thoſe two ſorts of ſubſtances; and, probably, is of a middle nature; for out of it grow all vegetable and animal ſubſtances; which conſiſt as well of ſulphureous, fat, and inflammable parts, as of earthy, lean, and alcalizate ones. Salts and vitriols have refractive powers in a middle degree, between thoſe of earthy ſubſtances and water; and, accordingly, are compoſed of thoſe two ſorts of ſubſtances. For by diſtillation, and rectification of their ſpirits, a great part of them goes into water; and a great part remains behind, in the form of a dry, fixed earth, capable of vitrification. Spirit of wine has a refractive power in a middle degree, between thoſe of water and oily ſubſtances; and, accordingly, ſeems to be compoſed of both, united by fermentation; the water, by means of ſome ſaline ſpirits, with which 'tis impregnated, diſſolving the oil, and volatilizing it by the action. For ſpirit of wine is inflammable, by means of its oily parts; and being diſtilled often from ſalt of tartar, grows by every diſtillation more and more aqueous and phlegmatic. And chymiſts obſerve, that vegetables, diſtilled *per ſe*, before fermentation, yield oils without any burning ſpirits; but after fermentation, yield ardent ſpirits, without oils; which ſhews, that their oil is by fermentation converted into ſpirit. They find alſo, that if oils be poured, in ſmall quantity, upon fermenting vegetables, they diſtil over, after fermentation, in the form of ſpirits.

"Since then all bodies ſeem to have their refractive powers proportional to their denſities, or very nearly, excepting ſo far as they partake more or leſs of ſulphureous, oily particles; and thereby have their refractive powers made greater; it ſeems rational to attribute the refracting power of all bodies, chiefly, if not wholly, to the ſulphureous parts with which they abound. For it's probable, that all bodies, more or leſs, abound with ſulphurs. And as light, congregated by a burning glaſs, acts moſt upon ſulphureous bodies, to turn them into flame and fire; ſo, ſince all action is mutual, ſulphurs ought to act moſt upon light. For that the action between light and bodies is mutual, appears, in that the denſeſt bodies, which refract and reflect light moſt ſtrongly, grow hotteſt in the ſummer ſun, by the action of the refracted or reflected light." *Newton. Optic.* p. 248—251.

it were eaſie to ſhew, that ſuch differently figured corpuſcles, may be mixed in ſuch various proportions, and be connected ſo many ſeveral ways, that an almoſt incredible number of variouſly qualified concretes, may be compoſed of them. Nay, the corpuſcles of one element, may barely, by being aſſociated among themſelves, make up little maſſes of a different ſize and figure from their conſtituent parts; whilſt to the ſtrict union of ſuch minute bodies, there often ſeems nothing requiſite, but the bare contact of a great part of their ſurfaces. And how great a variety of phenomona, the ſame matter, without the addition of any other, only ſeveral ways diſpoſed or rang'd, is able to exhibit, may appear by the multitude of different engines, which, by the contrivance of ſkilful mechanics, and the dexterity of expert workmen, might be made of iron alone. But, in our caſe, being allowed to deduce compound bodies from four very differently qualified ſorts of matter; what we ſaid of new concretes reſulting from the mixture of incorporated minerals, will not admit it to be doubted, that four elements, managed by the ſkill of nature, may afford a multitude of different compounds.

But the *Ariſtotelian* hypotheſis, is not comparable to the mechanic doctrine of the bulk and figure of the ſmalleſt parts of matter; for from theſe more univerſal and fruitful principles of the elementary matter, may ſpring a great variety of textures; upon whoſe account, a multitude of compound bodies, might greatly differ from one another. What is here ſaid of the four *Peripatetic* elements, may be alſo applied, *mutatis mutandis*, to the chymical principles. And both of them muſt, I fear, call in to their aſſiſtance, ſomething that is not elementary, to excite, or regulate the motion of the parts of matter, and diſpoſe them after the manner requiſite to conſtitute particular concretes.

Various ſubſtances obtainable from bodies, by fire.

From moſt of thoſe mixed bodies, which partake either of an animal, or a vegetable nature, there may, perhaps, by the help of the fire, be obtained a determinate number of ſubſtances, deſerving different denominations.

The truth of this aſſertion ſeems manifeſt, or, however, will ſufficiently appear hereafter.

It may, likewiſe, be granted, that thoſe diſtinct ſubſtances, which concretes either generally afford, or conſiſt of, may, without great inconvenience, be called the elements, or principles of them.

Whether fire be the proper inſtrument for analyſing mixed bodies?

Notwithſtanding what common chymiſts have taught, it may reaſonably be doubted, how far, and in what ſenſe, fire ought to be eſteemed the genuine and univerſal inſtrument of analyzing mixed bodies.

It were to be wiſh'd, our chymiſts had told us clearly, what kind of diviſion of bodies by fire, muſt determine the number of the elements; for it is not near ſo eaſy, as many think, to determine diſtinctly the effects of heat. Thus guaiacum, for inſtance, burnt

with

Chymiſtry.

with an open fire, is reduced into aſhes and ſoot; tho' the ſame wood, diſtilled in a retort, is reſolv'd into oil, ſpirit, vinegar, water, and charcoal; the laſt whereof, to be reduced into aſhes, requires a farther calcination than can be given it in a cloſe veſſel. Again; having kindled amber, and held a clean, concave, ſmooth veſſel, over the ſmoke of its flame; I found the ſoot, into which that fume condens'd, to be very different from any thing I had obſerved to proceed from the ſteam of amber, purpoſely diſtill'd *per ſe*, in cloſe veſſels. Thus, having kindled camphire, and catch'd the ſmoke that plentifully aſcended out of the flame, it condens'd into a black and unctuous ſoot; which would not have been gueſs'd by the ſmell, or other properties, to have proceeded from camphire: but expoſing a quantity of that fugitive concrete, to a gentle heat, in a cloſe, glaſs veſſel; it ſublimed up, without ſeeming to have loſt any thing of its whiteneſs or nature; both which it retained, tho' I afterwards ſo increaſed the fire, as to bring it to fuſion. And beſides camphire, there are ſeveral bodies, in which the heat in cloſe veſſels makes no ſeparation of heterogeneous parts, but only a comminution; thoſe that riſe firſt being homogeneal with the others, tho' ſubdivided into ſmaller particles; whence ſublimations have been ſtyled the peſtles of the chymiſts. Common brimſtone, once or twice ſublimed, and ſubmitted to a moderate fire in ſubliming pots, riſes all into dry, and almoſt taſtleſs flowers; tho', being expos'd to a naked fire, it affords much of a ſaline, fretting liquor. And as it is conſiderable in the analyſis of mixed bodies, whether the fire acts on them, while they are expos'd to the open air, or ſhut up in cloſe veſſels; ſo the degree of fire, by which we attempt the analyſis, is of no ſmall moment; for a mild *Balneum* will ſeparate unfermented blood, for inſtance, only into phlegm, and *Caput mortuum*. In making ſope, the ſalt, the water, and the oil, or greaſe, whereof that factitious concrete conſiſts, being boiled up together, are eaſily brought to mix and incorporate into one maſs, by one degree of heat; but the ſame maſs may be again divided into an oleagenous, an aqueous, a ſaline, and an earthy part, by a greater. And ſo we may obſerve, that impure ſilver and lead, being expoſed together to a moderate fire, will, thereby, be fuſed into one maſs, and mixed *per minima*; tho' a much more vehement fire would carry off the baſer metal. Beſides, when a vegetable, abounding in fix'd ſalt, is analyz'd by a naked fire; as one degree of heat will reduce it into aſhes, ſo by only the farther increaſe of fire, thoſe aſhes may be turn'd into glaſs. And, by the way, if aſhes paſs for an element, becauſe they are producible by one degree of fire; why may not glaſs be one of the elements of many bodies, ſince that, alſo, may be obtained barely by the fire? By a proper method of applying the fire, ſuch ſimilar bodies may be obtained from a concrete, as chymiſts have not been able to ſeparate, barely by burning it in an open fire, or by barely diſtilling it in cloſe veſſels. To me it ſeems very conſiderable, tho' it is greatly overlook'd, that from any of the common ways of diſtillation in cloſe veſſels, no ſeparation is made of ſuch a volatile ſalt as wood affords, when 'tis firſt, by an open fire, divided into aſhes and ſoot, and that ſoot is afterwards plac'd in a ſtrong retort, and compell'd, by an urgent fire, to part with its ſpirit, oil, and ſalt; for tho' I dare not peremptorily deny, that in the liquors of guaiacum, and other woods, diſtill'd in retorts after the common manner, there may be ſaline parts, which, by reaſon of the analogy, may pretend to the name of ſome kind of volatile ſalt; yet, queſtionleſs, there is a great difference betwixt ſuch ſalts, and that we have, ſometimes, obtain'd upon the firſt diſtillation of ſoot. For we cou'd never yet ſee ſeparated from woods, analyz'd only after the vulgar manner, in cloſe veſſels, any volatile ſalt in a dry and ſaline form, as that of ſoot; which we have often had very cryſtalline and geometrically figured. And then as the ſaline parts of the ſpirits of guaiacum, *&c.* appear ſluggiſh upon diſtillation, the ſalt of ſoot ſeems to be one of the moſt volatile bodies in nature; and if it be well made, will readily aſcend with the mild heat of a furnace, warm'd only by the ſingle wieck of a lamp, to the top of the higheſt glaſs-veſſels, commonly made uſe of for diſtillation. Beſides all this; the taſt and ſcent of the ſalt of ſoot are exceeding different from thoſe of the ſpirit of guaiacum, *&c.* for the former, not only ſmells and taſts much leſs like a vegetable ſalt, than like that of harts-horn, and other animal concretes; but in many other properties ſeems more allied to the family of animal, than to that of vegetable ſalts. I might ſhew, by other examples, that the chymiſts, to have dealt clearly, ought to have more explicitly and particularly declared, by what degrees of fire, and in what manner of application of it, they wou'd have us judge a diviſion, made by its means, to be a true analyſis into their principles. But I proceed to mention other particular reaſons why I doubt, whether fire be the true and univerſal analyzer of mix'd bodies.

In the next place, I obſerve there are ſome mix'd bodies, from which it has not yet been made appear, that any degree of fire can ſeparate either ſalt, or ſulphur, or mercury, much leſs all the three. The moſt obvious inſtance of this truth is gold; a body ſo fix'd and wherein the elementary ingredients, if it has any, are ſo firmly united to each other; that we find not in the operations, wherein gold is expoſed to the moſt vehement fire, that it, diſcernibly, ſo much as loſes of its fixedneſs or weight; ſo far is it from being reſolv'd into thoſe principles, whereof one, at leaſt, is acknowledg'd to be fugitive. *Caſto Claveus,* who, tho' a lawyer by profeſſion, ſeems to have had no ſmall curioſity and experience in chymiſtry, relates, that having put into one ſmall earthen veſſel an ounce of the moſt pure gold, and into another the like weight of pure ſilver, he placed them both in that part of a glaſs-houſe furnace, wherein the workmen keep their metal continually melted; and that having there kept both the gold and the ſilver in conſtant fuſion, for two months together, he afterwards took them out of the furnace; and weighing both of them again, found, that the ſilver had not loſt above a twelfth part of its weight, and the gold nothing at all.*

And tho', perhaps, there be no other body ſo perfectly fix'd as gold; yet there are many others ſo compos'd, that I have not yet obſerv'd the fire to ſeparate from them any one of the chymical principles. I need not relate what complaints the more candid and judicious chymiſts themſelves make of thoſe boaſters, who confidently pretend, they have extracted the ſalt or ſulphur of quickſilver, when they only diſguize it, till it reſembles the concretes, whoſe names are given it; whilſt, by a skilful and rigid examination, it may be eaſily ſtript of its dreſs, and made to appear again in the priſtine form of running mercury: theſe pretended ſalts and ſulphurs being ſo far from elementary parts, extracted out of mercury, that they are rather re-compounded bodies, made up of the whole metal and the menſtruum, or other additions. And as for ſilver, I never ſaw any degree of fire make it part with ſo much as one of its three principles. The experiment of *Claveus* might, indeed, give a ſuſpicion, that ſilver may be diſſipated by fire, provided it be extremely violent, and very laſting; yet it will not, neceſſarily, follow, that, becauſe the fire was able, at length, to make the ſilver loſe a little of its weight, it was, therefore, able to diſſipate it into its principles; for I have obſerv'd little grains of ſilver to lie hid in the ſmall cavities of crucibles, wherein that metal had been long kept in fuſion; whence ſome goldſmiths of my acquaintance make a profit, by grinding ſuch crucibles to powder, to recover out of them the latent particles of ſilver; and hence I might argue, that, perhaps, *Claveus* was miſtaken, and imagin'd that ſilver to have been driven away by the fire, which, indeed, lay in minute parts, hid in his crucible; for ſo ſmall a quantity as he miſs'd, of ſo ponderous a body, might be eaſily conceal'd in the pores thereof.

But admitting, that ſome parts of the ſilver were driven away by the violence of the fire; what proof is there that it was either the ſalt, the ſulphur, or the mercury of the metal, and not rather a part of it, homogeneous to what remain'd? For, beſides that the ſilver left behind, ſeem'd not ſenſibly alter'd, which it, probably, wou'd have appeared, had ſo much of any one of its principles been ſeparated from it; we find in other mineral bodies, of a leſs permanent nature, that the fire may divide them into ſuch minute parts, as to carry them away with it ſelf; without at all deſtroying their nature. Thus we ſee, that in the refining of ſilver, the lead that is mix'd therewith,

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* Gold expoſed to the ſun's rays, thrown to a point, either by a large glaſs lens, or a burning concave, will fume, be ſcattered, and diſſipated into ſmall drops, be vitrified, and loſe of its weight; whence, ſays M. *Homberg*, this noble metal is not ſo fixed as chymiſts commonly pretend: and thus, all metals are volatile with regard to a heat ſufficiently vehement. See *French Memoirs, A.* 1702. *p.* 186—197.

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to carry away the copper, or other ignoble mineral that debaſes it, will, if let alone, evaporate in time, upon the teſt; but if, as 'tis moſt uſual amongſt ſuch as refine great quantities of metals together, the lead be blown off from the ſilver, by bellows; that which wou'd, otherwiſe, have eſcaped in the form of unheeded ſteams, will, in great part, be collected near the ſilver, in the form of a darkiſh powder, call'd, litharge of ſilver. And thus *Agricola* informs us, when copper, or the ore of it, is fuſed by the violence of the fire with *Cadmia*; ſome of the ſparks, which, in great multitudes, fly upwards, ſtick to the vaulted roofs of the furnaces, in the form of little white bubbles, which,therefore,the *Greeks* call *Pompholyx*; whilſt others more heavy, partly adhere to the ſides of the furnace, or fall to the ground; and by reaſon of their aſhy colour, as well as weight, are termed σποδος. I might add, I have not found, that from *Venetian* talc, from the *Lapis Oſſifragus*, or *Oſteocolla*, from *Muſcovy* glaſs, from pure and fuſible ſand, *&c.* ſuch of my acquaintance as have try'd, were able, by the fire, to ſeparate any one of the hypoſtatical principles. Glaſs, we know, is made by the pure colliquation of the ſalt and earth, remaining in the aſhes of a burnt plant; yet common glaſs ſo far reſiſts the violence of the fire, that moſt chymiſts think it a body leſs apt to be deſtroyed than gold it ſelf. But if the artificer can ſo firmly unite ſuch comparatively groſs particles, as thoſe of earth and ſalt, that make up common aſhes, into a body indiſſoluble by fire; why may not nature aſſociate, in ſeveral bodies, the more minute elementary corpuſcles, too firmly, to let them be parted by the fire? Having put a quantity of camphire into a glaſs-veſſel, and plac'd it in a gentle heat, I found it to ſublime to the the top of the veſſel in flowers; without leaving the weight of a ſingle grain behind: and theſe in whiteneſs, ſmell, *&c.* ſeemed not to differ from the camphire it ſelf. *Helmont* affirms, that a coal, kept in a glaſs exactly cloſed, will not be calcined to aſhes; tho' detain'd ever ſo long in a ſtrong fire. And indeed, having ſometimes diſtilled ſuch woods as box; whilſt our *Caput mortuum* remain'd in the retort, it continued black, like charcoal, tho' the retort were of earth, and kept red hot in a vehement fire; but as ſoon as ever it was brought out of that veſſel into the open air, the burning coals would ſuddenly degenerate, or fall aſunder, without the aſſiſtance of any new calcination, into pure white aſhes. Laſtly, 'tis known, that common ſulphur, if pure, and freed from its vinegar, leiſurely ſublimed in cloſe veſſels, riſes into dry flowers; which may be preſently melted into a body, of the ſame nature with that which afforded them: tho' if brimſtone be burnt in the open air, it yields a penetrating fume, which being caught in a glaſs-bell, condenſes into that acid liquor, called, oil of ſulphur *per campanam*. Hence it appears, that even among the bodies that are not fixed, there are ſeveral of ſuch a texture, that the fire, as chymiſts employ it, cannot eaſily reſolve them into elementary ſubſtances. For, ſome bodies being of ſuch a texture, that the fire can drive them into the cooler part of the veſſels, wherein they are included; and, upon occaſion, remove them from place to place, ſo that they fly the greateſt heat more eaſily, than it can divorce their elements, eſpecially without the aſſiſtance of the air; we ſee, that our chymiſts cannot analyze them in cloſe veſſels: and from other compound bodies, the open fire can as little ſeparate the elements; for what can a naked fire do to analyze a mix'd body, if its component principles be ſo minute, and ſo firmly united, that the corpuſcles of it need leſs heat to carry them up, than is requiſite to divide them into their principles *? So that of ſome bodies, the fire cannot in cloſe veſſels, make any analyſis at all; and others will, in the open air, fly away in the forms of flowers or liquors, before the heat is able to divide them into their principles. And this may hold, whether the various, ſimilar parts of a concrete, be combined by nature, or by art; for in factitious ſal-armoniac, we find the common and the urinous ſalts ſo well mixed, that both in the open fire, and in ſubliming veſſels, they riſe together as one ſalt; which ſeems in ſuch veſſels irreſoluble by fire alone. For I have ſome ſal-armoniac, which, after the ninth ſublimation, ſtill retains its compound nature. And, indeed, I ſcarce know any one mineral, from which, by fire alone, chymiſts ſever any ſubſtance, ſimple enough to deſerve the name of an element, or principle. For, tho' out of native cinnabar, they diſtil quick-ſilver; and tho' from many of thoſe ſtones the ancients call'd *Pyrites*, they ſublime brimſtone; yet both that quick-ſilver, and this ſulphur, being very often the ſame with common minerals, are themſelves too compounded, to paſs for the elements of theſe.

But further; there are many ſeparations to be made by other means, which either cannot at all, or not ſo well, be made by the fire alone. When gold and ſilver are melted into one maſs, it would lay a great obligation upon refiners and goldſmiths, to teach them the art of ſeparating them by fire; † without the trouble and charge they are at to do it; tho' they may be very eaſily parted by ſpirit of nitre, or *Aqua fortis*. Thus, likewiſe, the metalline part of vitriol, will not be ſo eaſily and conveniently ſeparated from the ſaline, even by a violent fire, as by the affuſion of certain alkaline ſalts, in a liquid form, upon the ſolution of vitriol made in common water. For hereby the acid ſalt of the vitriol, leaving the copper it had corroded, to join with the ſalts that were added; the metalline part will be precipitated to the bottom, almoſt like mud. The vulgar chymiſts have not been able, by fire alone, to ſeparate pure ſulphur from antimony; but tho' there are in their books many plauſible proceſſes for extracting it, yet he who ſhall make as many fruitleſs trials, as I have done, to obtain it by moſt of them, will be eaſily perſuaded, that the productions of ſuch proceſſes are antimonial ſulphurs, rather in name, than nature. But tho' antimony, ſublimed by it ſelf, is reduced only to a volatile powder, or to antimonial flowers, of a compound nature, like the mineral that affords them; yet I have, by a particular method, ſublimed out of antimony, a larger proportion of ſulphur, than ever I otherwiſe ſaw obtain'd out of that mineral. For, having digeſted eight ounces of fine pulverized antimony, with twelve ounces of oil of vitriol, in a well clos'd glaſs, for about ſix or ſeven weeks; and having cauſed the maſs, now grown hard and brittle, to be diſtilled in a retort placed in ſand, with a ſtrong fire; we found the antimony to be ſo open'd, or alter'd, by the menſtruum, wherewith it had been digeſted, that tho' crude antimony, forced up by the fire, riſes only in flowers, ours thus treated, afforded in the receiver, and at the top of the retort, about an ounce of ſulphur, yellow and

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* Hence it is, that the analyſis of common ſulphur proves ſo very difficult; for the principles whereof it is compoſed are ſo volatile, and ſo firmly connected together, that they are apt to riſe at once. M. *Homberg*, however, found, that this mineral is reſolvable into an acid ſalt, a very fixed earth, an unctuous, bituminous, and inflammable ſubſtance; and ſometimes, a ſmall quantity of metal, which he diſcover'd to be copper. The acid proved to be the ſame with that of vitriol. See *French Memoirs*, *A.* 1703. *p:* 36.

† The common way of ſeparating gold from ſilver, when theſe two metals are mixed together, is, indeed, troubleſom, and expenſive; but M. *Homberg* ſhews us a much more eaſy, and leſs chargeable, method, of doing it by fuſion; which he accidentally diſcover'd. In order to reduce ſome very fine grains of a mixture of equal parts of gold and ſilver, into one lump, he put them into a crucible, at the bottom whereof lay about equal parts of ſalt-peter, and decrepitated ſalt; this crucible he placed in a melting furnace, with a gentle fire; and taking it out in a quarter of an hour's time, and ſuffering it to cool, he broke it; when, to his ſurprize, he found the gold in a lump at the bottom, the

ſilver.

ſilver in two pieces, and ſome grains above it, cover'd over with the ſalts. By repeated trials, M. *Homberg* afterwards found, that to make the ſeparation exact, the quantity of the metals ought to be nearly equal; and that the fire muſt not be violent. He farther obſerves, that the ſalts, whilſt they are not in perfect fuſion, ſuſtain the mixed metal, when it begins to melt, and ſerve as a kind of ſieve to it; permitting the heavier part, the gold, to paſs through, and retaining the lighter, the ſilver, which in this caſe, is not ſo well fuſed as the gold. So that, if at the right juncture, the crucible be taken from the fire, the ſilver preſently hardens; being become fine, upon ſeparating from the gold, and cannot be fuſed again, without a violent fire. The ſalts, in the mean time, which ſuſtain this ſilver, being but imperfectly fuſed, prevent the ſilver from falling to the bottom of the crucible, and mixing again with the gold. *French Memoirs*, *A.* 1713. *p.* 89, — 91.

He, likewiſe, ſhews, that when ſilver is debaſed by copper, it may, with great eaſe and cheapneſs, be excellently purified, by calcining it with half its weight of common brimſtone; and when the whole is melted together, throwing on, at ſeveral times, a ſufficient quantity of the filings of iron, which quantity may be eaſily judged of in the operation. By this means, the ſulphur will immediately leave the ſilver, and unite with the iron and copper; and turning to droſs, float at the top, and leave the ſilver pure at the bottom of the crucible. The proceſs muſt be ſtopp'd, as ſoon ever the iron is perfectly fuſed; otherwiſe, a part of the copper will be precipitated, and mixing with the ſilver, cauſe the work to be began afreſh. *French Memoirs*, *A.* 1701. *p.* 53 — 56.

brittle, like common brimſtone; and of ſo ſulphureous a ſmell, that, upon unluting the veſſels, it infected the room with a fetor ſcarce ſupportable. This ſulphur had alſo the perfect inflammability of common brimſtone; and would immediately kindle at the flame of a candle, and burn blue like that. The long digeſtion, indeed, wherein our antimony and menſtruum were detained, ſeem'd conducive to the better unlocking of the mineral; yet, by incorporating with powder'd antimony, a convenient quantity of oil of vitriol, and committing them immediately to diſtillation, there may be obtained a little ſulphur, like the common, and more combuſtible than, perhaps, will at firſt be taken notice of. For I have obſerved, that after its being firſt kindled, the flame would ſometimes go out too ſoon of it ſelf; but if the ſame lump were held again to the candle, it would rekindle, and burn for a pretty while, even after the third or fourth extinction. As ſomething ſulphureous may be diſcover'd in oil of vitriol, 'tis natural to ſuſpect, either that this ſubſtance was ſome ſulphur which lay hid in that liquor, and was, by this operation only, reduced into a manifeſt body; or elſe, that it was a compound of the unctuous parts of the antimony, and the ſaline ones of the vitriol: becauſe many would have ſulphur to be only a mixture, made in the bowels of the earth, of vitriolic ſpirits, and a certain combuſtible ſubſtance *. But the quantity of ſulphur we obtained by digeſtion, was much too great to have been latent in the oil of vitriol; and that vitriolic ſpirits are not neceſſary to the conſtruction of ſuch a ſulphur as ours, I could eaſily manifeſt, from the ſeveral ways by which I have obtained, tho' not in ſuch plenty, a ſulphur of antimony, colour'd and combuſtible like common brimſtone. And to ſhew, that diſtill'd, vitriolic ſpirits, are not neceſſary to the obtaining of ſuch a ſulphur, as we have been conſidering; I did, by the bare diſtillation of ſpirit of nitre, from its weight of crude antimony, ſoon ſeparate a yellow, and very inflammable ſulphur; which, for ought I know, deſerves as much the name of an element, as any thing the chymiſts ſeparate from any mineral by the fire. And tho' the urinous and common ſalts, whereof ſal-armoniac conſiſts, remain'd, as we ſaid, unſever'd by the fire, in many ſucceſſive ſublimations; yet, they may be eaſily ſeparated, by pouring upon the concrete, finely powder'd, a ſolution of ſalt of tartar, or of the ſalt of wood-aſhes; for, upon diligently mixing of theſe, a very ſtrong ſcent of urine will enſue; and, perhaps, a ſharp pain in the eyes, if held too near. Both theſe effects proceed from hence, that by the alkaline ſalt, the

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* M. *Geoffroy* ſhews, that the mixture of any vitriolic ſalts with inflammable ſubſtances, will yield common brimſtone; and by the different compoſitions he has made of ſulphur, and particularly from oil of vitriol, and oil of turpentine; and by the analyſis thereof, when thus prepared, he diſcover'd it to be nothing but the vitriolic ſalt, united with the combuſtible ſubſtance. *French Memoirs, A.* 1704. *p.* 381.

ſea-ſalt that enter'd the compoſition of the ſal-armoniac, is rendred more fixed; and thereby a divorce is made between it, and the volatile, urinous ſalt; which being, at once, ſet at liberty, and put into motion, begins preſently to fly away, and to offend the noſtrils and eyes it meets with in its way. And if the operation of theſe ſalts be, in convenient glaſſes, promoted by warmth, even that of a bath, the aſcending ſteams may eaſily be caught, and reduced into a penetrant ſpirit, abounding with a ſalt; which I have ſometimes found to be ſeparable in a cryſtalline form. I might add, that tho' ſublimate, conſiſting of ſalts and quick-ſilver, combined and carried up together by heat, may be many times ſublimed by a like degree of fire, without ſuffering any divorce of the component bodies; yet the mercury will be eaſily ſever'd from the adhering ſalts. But I rather obſerve, what may ſeem ſtrange, that by ſuch an addition, as ſeems only to promote the ſeparation, there may eaſily be obtained from a concrete, that by the fire alone is readily diviſible into all the elements whereof vegetables are ſuppoſed to conſiſt, a ſimilar ſubſtance, that differs in many reſpects from them all. For I have practis'd a way, whereby common tartar, without the addition of any thing that is not perfectly a mineral, except ſalt-petre, may, by one diſtillation, in an earthen retort, be made to afford plenty of real ſalt, ready diſſoluble in water; which I found to be neither acid, nor of the ſmell of tartar; and to be almoſt as volatile as ſpirit of wine; and, indeed, of a very different nature from all that is uſually ſeparated by fire from tartar.

The fire, even when it divides a body into ſubſtances of various conſiſtences, does not commonly analyze it into hypoſtatical principles, but only diſpoſes its parts into new textures; and thereby produces concretes, of a new, indeed, but compound nature. And this we ſhall abundantly make good hereafter.

Several diſtinct ſubſtances are obtainable from ſome concretes, without the aſſiſtance of fire; which no leſs deſerve the name of elementary, than ſome which chymiſts extort by the violence of it.

We ſee, that the inflammable ſpirit of wine may not only be ſeparated by the gentle heat of a bath, but may be diſtill'd, either by the help of the ſun-beams, or even of a dunghill; being, indeed, of ſo fugitive a nature, that it is not eaſy to keep it from flying away, even without the application of external heat. I have likewiſe obſerved, that a veſſel full of urine, being plac'd in a dunghil, the putrefaction, after ſome weeks, uſually opens the body; ſo that the parts disbanding the ſaline ſpirit, will, within no very long time, if the veſſel be not ſtopt, fly away of it ſelf; whence from ſuch urine, I have been able to diſtil little or nothing, beſides a nauſeous phlegm; inſtead of the active and piercing ſalt and ſpirit that it would have afforded, when firſt expos'd to the fire, if the veſſel had been carefully ſtopt.

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It will be very hard to prove, that there can no other body, or way be found, which will, as well as the fire, divide concretes into ſeveral homogeneous ſubſtances, that might, conſequently, be call'd their elements, or principles, as well as thoſe ſeparated or produced by the fire. For ſince we have ſeen, that nature can ſucceſsfully employ other inſtruments than the fire, to ſeparate diſtinct ſubſtances from mixed bodies; how know we, but that ſhe has made, or art may make, ſome ſubſtance a fit inſtrument to analyze them; or that ſome ſuch method may not be found by human induſtry or chance; by means whereof compound bodies may be reſolved into other ſubſtances, than fire divides them into. And why the products of ſuch an analyſis, may not as juſtly be called the component principles of the bodies that afford them, will not be eaſily ſhewn; eſpecially ſince I ſhall hereafter make it evident, that the ſubſtances which chymiſts term ſalts, ſulphurs, and mercurys of bodies, are not ſo pure and elementary as they preſume. And this may, therefore, be more freely preſs'd upon the chymiſts, becauſe neither the *Paracelſians*, nor the *Helmontians*, can reject it, without apparent injury to their maſters. For *Helmont* more than once informs his reader, that both *Paracelſus* and himſelf poſſeſs'd the famous liquor alkaheſt; which, for its great power in reſolving bodies irreſoluble by vulgar fires, he ſeems to call *Ignis Gehennæ*. To this liquor he aſcribes, and that in great part upon his own experience, ſuch wonders, that if we ſuppoſe them true, the alkaheſt ſeems a nobler and more deſireable ſecret, than the philoſopher's ſtone. Of this univerſal reſolvent he relates, that having digeſted with it for a competent time, a piece of oaken charcoal, it was thereby reduced into two new liquors, and different from each other in their colour and ſituation; and that the whole body of the coal was reduced into theſe liquors, both of them ſeparable from his immortal menſtruum; which remained as fit for ſuch operations as before. And he, moreover, ſeveral times tells us, that by his powerful and unwearied agent, he could diſſolve metals, marcaſites, ſtones, vegetable and animal bodies, of what kind ſoever, even glaſs it ſelf, and, in a word, all kinds of mixed bodies in the world, into their ſeveral ſimilar ſubſtances, without any reſidence, or *Caput mortuum*. And, laſtly, we may gather this further from his informations, that the homogeneous ſubſtances obtainable from compound bodies by his penetrating liquor, were often very different, both as to number and nature, from thoſe into which the ſame bodies are uſually divided by common fire; for in our common analyſis of a mixed body, there remains a terreſtrial, and very fixed ſubſtance, often aſſociated with a ſalt as fixed; while our author declares, that by his way he could diſtil over all concretes, without any *Caput mortuum*; and, conſequently, could make thoſe parts of the concrete volatile, which, in the vulgar analyſis, would have been fix'd. So that if our chymiſts will not reject the ſolemn and repeated

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teſtimony of a perſon, acknowledged one of the greateſt in their way; they muſt not deny, that there is in nature another agent, able to analyze compound bodies with leſs violence, more genuinely and more univerſally than the fire. And, for my own part, tho' I always ſay, in caſe of any ſtrange experiment; "he who hath ſeen it, hath more "reaſon to believe it, than he who has not;" yet I have found *Helmont* ſo faithful a writer, even in ſeveral of his improbable experiments, that I think it ſomewhat harſh to give him the lie; eſpecially in what he delivers upon his own proper trial. And having received ſome things from very credible eye-witneſſes, and ſeen others my ſelf, which argue ſo ſtrongly, that a circulated ſalt, or a menſtruum, may, by being extracted from compound bodies, leave them more unlock'd, than a wary naturaliſt would eaſily credit; I dare not confidently meaſure the power of nature, and of art, by that of the menſtrua, and other inſtruments, which even eminent chymiſts employ, about the analyzing of bodies; nor deny, that a menſtruum may, from a particular concrete, extract ſome apparently ſimilar ſubſtance, different from any obtainable from the ſame body, by whatever degree of fire, or manner of its application. And I am the more unwilling peremptorily to deny, that there may be ſuch openers of compound bodies; becauſe among the experiments which make me ſpeak thus cautiouſly, there were ſome in which it appear'd not that one of the ſubſtances, inſeparable by common fires and menſtrua, could retain any thing of the ſalt whereby the ſeparation was made.

Some chymiſts, I know, will here reply, that they pretend not, by fire alone, to ſeparate their hypoſtatical principles out of all compound bodies; it being ſufficient that the fire divides them into ſuch, tho' afterwards they employ other bodies to collect the ſimilar parts of the compound; as 'tis known, that tho' they make uſe of water to collect the ſaline parts of aſhes from the terreſtrial, wherewith they are blended; yet it is the fire only that incinerates bodies, and reduces the fixed part of them into the ſalt and earth, whereof aſhes conſiſt. But I here only argue againſt thoſe vulgar chymiſts, who themſelves believe, and would perſwade others, that the fire is not only an univerſal, but an adequate and ſufficient inſtrument to analyze mix'd bodies with. For, as to their practice of extracting the fix'd ſalt out of aſhes, by the affuſion of water, 'tis obvious to alledge, that the water only aſſembles together the ſalt, which the fire had before divided from the earth; as a ſieve does not further break the corn, but only bring together, into two diſtinct heaps, the flower, and the bran; whoſe corpuſcles before lay promiſcuouſly blended in the meal.

But tho' I allow the chymiſts, after the fire has done its office, the uſe of fair water to make their extractions with, in ſuch caſes wherein the water does not co-operate with the fire, to make the analyſis; yet ſince I grant this, but upon ſuppoſition, that the water only waſhes off the ſaline particles which the fire alone has before extricated in the analyz'd body, it is not reaſonable to extend this conceſſion to other liquors that may add to what they diſſolve.

And this premis'd, I obſerve, that many of the preceding inſtances, are ſuch as the objection will not at all reach. For fire can no more, with the aſſiſtance of water, than without it, ſeparate any of the three principles from gold, ſilver, mercury, *&c.*

Hence we may infer, that fire is not an univerſal analyzer of mix'd bodies; ſince of the metals and minerals, wherein chymiſts have moſt exerciſed themſelves, there appear ſcarce any which they are able to analyze by fire, or from which they can unqueſtionably ſeparate, even any one of their hypoſtatical principles.

It will alſo remain true, notwithſtanding the objection, that there may be other ways than the uſual analyſis by fire, to ſeparate from a compound body ſubſtances, as homogeneous as thoſe which chymiſts ſcruple not to reckon among their three principles; that with convenient additions, ſuch ſubſtances may be ſeparated by the help of the fire, as cou'd not be ſo by the fire alone, witneſs the ſulphur of antimony; and laſtly, ſince it appears too, that the fire is but one of the inſtruments that muſt be employed in the reſolution of bodies; whenever any menſtruum or other addition is employed together with the fire, to obtain a ſulphur or a ſalt from a body, we may well take the freedom to examine, whether or no, that menſtruum hereby helps to ſeparate the principle obtain'd by it, or whether there intervenes not a coalition of the parts of the body wrought upon, with thoſe of the menſtruum; whence the produced concrete may be judg'd to reſult from the union of both. And it will be farther allowable for us to conſider, how far any ſubſtance, ſeparated by the help of ſuch addition, ought to paſs for one of the three principles; ſince by one way of handling the ſame mix'd body, it may, according to the nature of the addition, and the method of working upon it, yield ſubſtances different from thoſe it may afford by other additions, and a different method. Nay, they may, as we formerly ſaid, differ from any of the ſubſtances into which a concrete is diviſible by the fire without additions, tho', perhaps, thoſe additions do not, as ingredients, enter the compoſition of the body obtain'd; but only diverſify the operation of the fire upon the concrete, which, by the fire alone, may be divided into as great a number of different ſubſtances, as any of the chymiſts teach that of their elements to be.

But many *Peripatetics*, to prove fire the true analyzer of bodies, will plead, that it is the very definition of heat given by *Ariſtotle*, to be “ that which aſſembles things of a ſimilar, and disjoins thoſe of an oppoſite nature.” To which I anſwer, that this effect is far from being ſo eſſential to heat as 'tis generally imagin'd; for the true and genuine property of heat is rather to put in motion, and thereby diſſociate the parts of bodies, and ſubdivide them without regard to their being homogeneous or heterogeneous; as appears in the boiling of water, the diſtillation of quick-ſilver, or the expoſing of bodies to the action of fire; where all that the fire can do is, to divide the body into very minute parts, which are of the ſame nature with one another, and with their wholes, as their reduction, by condenſation, proves. And even when the fire ſeems moſt to aſſociate ſuch things as are ſimilar, and diſjoin ſuch as are diſſimilar, it produces that effect only by accident; for the fire does but diſſolve, or rather ſhatter the frame or ſtructure that kept the heterogeneous parts of bodies together, under one common form; upon which diſſolution the component particles of the mix'd body being freed and ſet at liberty, naturally, and often without any operation of the fire, aſſociate themſelves each with its like, or rather take thoſe places which their ſeveral degrees of gravity or levity, fixedneſs or volatility, aſſign them. Thus in the diſtillation of human blood, the fire firſt begins to diſſolve the cement of the body, when the water being the moſt volatile and eaſie to be extracted, is either by the fiery atoms, or the agitation they are put into by the fire, firſt carried up till forſaken by that which rais'd it, its own weight ſinks it down into the receiver; but all this while the other principles of the concrete remain unſever'd, and require a ſtronger degree of heat to make a ſeparation of its more fix'd elements; and therefore the fire muſt be increaſed to carry over the volatile ſalt and the ſpirit, which, tho' ſuppoſed to be different principles, and tho' really of a different conſiſtence, are yet of an almoſt equal volatility. After theſe comes over the oil, and leaves behind the earth and the alkali; which, being equally fix'd, the fire fails to ſever them, notwithſtanding the definition of the ſchools. And if into a red hot iron retort, you caſt the matter to be diſtill'd, you may obſerve, that the predominant fire will carry up all the volatile elements, confuſedly, in one fume, which afterwards take their place in the receiver, either according to the degree of their reſpective gravity, or to the exigency of their ſeveral textures. Thus 'tis obſervable, that tho' oil, or liquid ſulphur, be one of the elements, ſeparated by the analyſis, yet the heat which accidentally unites the particles of the other volatile principles, has not always the ſame operation on this; for there are ſeveral bodies which yield two kinds of oils, whereof the one ſinks to the bottom of that ſpirit on which the other ſwims. And I have two oils, carefully made of the ſame parcel of human blood, which not only differ extremely in colour, but ſwim upon one another, without mixing; and if, by agitation, confounded, will, of themſelves, ſeparate again.

And that the fire often divides bodies, upon this account, that ſome of their parts are more fix'd, and others more volatile, how far ſoever either of the two may be from a pure, elementary nature, is obvious enough, in the burning of wood, which the fire diſſipates into ſmoke and aſhes; for not only the latter of theſe is confeſſedly made up of two ſuch different bodies, as earth and ſalt, but the former being condens'd into ſoot, diſcovers it ſelf to contain ſalt, oil, ſpirit and earth, with ſome portion of phlegm; all which being almoſt equally volatile, in that degree of fire which forces them up, are carried away together; but may afterwards be ſeparated by other degrees of fire, whoſe orderly gradation allows the difference of their volatility to diſcover it ſelf*. Beſides, if two different bodies, united into one maſs, be both ſufficiently fix'd, the fire, finding no parts volatile enough to be carried up, makes no ſeparation at all; as appears by a mixture of melted ſilver and gold, whoſe component metals may be eaſily ſeparated by *Aqua fortis*, or *Aqua regia*; but in the fire alone, tho' vehement, they remain unſever'd; that only dividing the body into ſmaller particles, in which either the little nimble atoms of fire, or its brisk and numberleſs ſtrokes upon the veſſels, hinder reſt and continuity, without producing any elementary principles. Moreover, the fire ſometimes does not ſeparate ſo much as unite bodies of a different nature; provided they be near allied in fixedneſs, and have in the figure of their parts, an aptneſs to coalition; as we ſee in making many plaſters, ointments, *&c.* and in ſuch metalline mixtures, as that made by melting together two parts of clean braſs, with one of pure copper; of which, ſome ingenious tradeſmen, caſt curious patterns for gold and ſilver works. Sometimes the bodies mix'd by the fire, are different enough, as to fixedneſs and volatility, yet ſo combined by the firſt operation of the heat, that it only afterwards ſerves to pulverize them. This is viſible in the preparation of *Mercurius dulcis*; where the ſaline particles of the vitriol, ſea-ſalt, or nitre, employ'd to make the ſublimate, ſo unite themſelves with the mercurial particles, made uſe of firſt to prepare the ſublimate, and then to dulcify it, that the ſaline and metalline parts riſe together in many ſucceſſive ſublimations, as if they all made but one body; and ſometimes too, the fire combines the different elements of a body ſo firmly, that nature her ſelf, very ſeldom makes leſs diſſoluble unions. For the fire meeting with ſome bodies exceedingly, and almoſt equally fix'd, inſtead of mak-

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* M. *Homberg* has been very curious to obtain, if poſſible, the true principles of plants by chymical analyſis. The reſult of his numerous experiments, is, that ſalt, oil, water, and earth, are conſtantly found in all vegetable productions, in what manner ſoever their analyſis be made; that, according to the difference in the operation, theſe principles are more or leſs volatile, or fixt; that their different volatility, and fixedneſs, may proceed as well from the fermentation of the body, as the force of the fire; that a ſtrong fire, by driving over all the principles at once, confounds the analyſis; that the fire always evaporates ſome parts of the ſubject, which can never be recover'd; that to obtain theſe principles, as pure as poſſible, only fermentation and a gentle fire ſhould be employ'd; and laſtly, that the conſtitution and virtue of every plant, conſiſting in the exact proportion, arrangement, and texture of its principles, the fire either deſtroys what ſets the difference between two very diſſimilar plants, or, the ſame vegetable, once analyzed, can ſcarce be perfectly reſtored. See *Hiſt. de l'Academ. R. A.* 1701. *p.* 86. and *Memoirs*, *p.* 148.

Chymiſtry. making a ſeparation, cauſes ſo ſtrict an union, that it ſelf alone is unable to diſſolve it; as when an alkaline ſalt, and the terreſtrial reſidue of the aſhes, are incorporated with pure ſand, and by vitrification, made one permanent body, the greeniſh ſort of glaſs, that eludes the greateſt violence of the fire. I have ſome pieces of glaſs, which I ſaw flow down from an earthen crucible, expos'd for a good while with ſilver in it, to a very vehement fire. And thoſe, who deal much in the fuſion of metals, inform me, that the melting of a great part of a crucible, is no great wonder in their furnaces. I remember I have obſerv'd too, in the melting of great quantities of iron out of ore, by the help of charcoal, that by the prodigious vehemence of the fire, part of the materials expos'd, was, inſtead of being analyz'd, fuſed, and turn'd into a dark, ſolid, and very ponderous glaſs; and this happens in ſuch quantities, that in ſome places, I have ſeen, the very high ways, near ſome iron-works, mended with ſuch lumps of glaſs. I have alſo obſerv'd, that ſome kind of fire-ſtone it ſelf, having been employ'd in furnaces, where it was expos'd to very ſtrong, and laſting fires, has had all its fix'd parts ſo wrought on thereby, as to be perfectly vitrified; as I have try'd, by forcing from it pretty large pieces of perfect, tranſparent glaſs. And to ſhew, that the preceding definition of heat, is not countenanced by that of its contrary quality cold, which is ſaid to aſſociate things homogeneous and heterogeneous; I muſt obſerve, that neither is this definition unqueſtionable: for the union of heterogeneous bodies, ſuppos'd to be the genuine production of cold, is not perform'd by every degree of that quality. We ſee, for inſtance, that when the urine of healthy men, has been ſuffer'd to ſtand for a while, the cold makes a ſeparation of the thinner part from the groſſer, which ſubſides to the bottom, and grows opake there; whereas, if the urinal be made warm, thoſe parts readily mix again, and the whole liquor becomes tranſparent as before. And when by glaciation, wood, ſtraw, duſt, water, *&c.* are ſuppos'd to be united into one lump of ice, the cold does not cauſe any real union of theſe bodies, but only hardening the aqueous parts of the liquor into ice, the other bodies being accidentally preſent in that liquor, are frozen up in it, not really incorporated. And accordingly, if we expoſe a heap of mony, conſiſting of gold, ſilver, and copper coins, or any other bodies of different natures, which are uncapable of congelation, to ever ſo intenſe a degree of cold; we find not they are at all ſo much as compacted thereby, much leſs united together: and even in liquors themſelves, we find phenomena, which induce us to queſtion the definition we are examining. If the authority of *Paracelſus* were a ſufficient proof in matters of this nature, I might here inſiſt on that proceſs of his, whereby he teaches, that the eſſence of wine may be ſtruck to the center, and ſever'd from the phlegm and ignoble part, by the aſſiſtance of congelation.

But I dare not lay much ſtreſs upon this proceſs, becauſe I have found, that if it were true, it would be but ſeldom practicable in this country upon the beſt wine; for in our ſharpeſt winters, I cou'd never tolerably freeze a thin vial of canary; and even with ſnow and ſalt, but little deeper than the ſurface: and I ſuppoſe it is not every degree of cold, capable of congealing liquors, which will make ſuch an analyſis of them by ſeparating their aqueous and ſpirituous parts; for I have, ſometimes, ſeverally frozen red wine, urine, and milk, but could not obſerve any ſeparation. And the *Dutch*, who winter'd in *Nova Zembla*, tho' they relate, that there was a ſeparation of parts made in their frozen beer, about the middle of *November*; yet of the freezing of their ſack in *December* following, they only ſay, "it was frozen very hard; ſo that when every man was to "have his part, we were forc'd to melt it in the fire." In which words they imply, not that their ſack was divided into different ſubſtances, as their beer had been. But notwithſtanding this, I am of opinion, that even cold may, ſometimes, unite ſimilar, and ſeparate diſſimilar ſubſtances. I once purpoſely caus'd a plant, abounding with ſulphureous and ſpirituous parts, to be boiled in fair water; and having expos'd the decoction to a ſharp north wind, in a very froſty night, I obſerv'd, that the more aqueous parts of it were, by the next morning, turn'd into ice; towards the innermoſt part of which, the more agile and ſpirituous portions, as I then conjectured, having retreated, they there preſerv'd themſelves unfrozen, in the form of a high color'd liquor; the aqueous and ſpirituous parts having been ſo ſlightly blended in the decoction, that they were eaſily ſeparable by ſuch a degree of cold, as would not have divorc'd the parts of urine or wine, which, by fermentation or digeſtion, are more intimately aſſociated with each other. But the *Dutch*, in *Nova Zembla*, found a barrel of beer ſo frozen, that the ſpirituous part appear'd ſeparated from the yeaſt, whilſt ſome on the outſide of the veſſel was frozen as hard as glue; the other, which was converted to ice, being almoſt inſipid.

And having once purpoſely try'd to freeze ſome beer, that was moderately ſtrong, in glaſs veſſels with ſnow and ſalt, I obſerv'd, that there came out of the neck a certain thick ſubſtance, which, it ſeems, was much better able than the reſt of the liquor, that I found turn'd into ice, to reſiſt the froſt; and which, by its colour and conſiſtence, ſeem'd manifeſtly to be yeaſt. This, I confeſs, ſomewhat ſurpriz'd me; becauſe I could not diſcern by the taſt, or find by enquiry, that the beer was too new, to be very fit for drinking. I might confirm the *Dutchmens* relation, by what lately happen'd to a friend of mine, who complain'd to me, that having brew'd ſome ale in *Holland*, the cold of the winter there, froze it into ice, and left only a ſmall proportion of a very ſtrong and ſpirituous liquor.

SECT. II.

That ſome things obtained from a body by fire, were not its proper ingredients.

IT is not ſo certain, as both chymiſts and *Ariſtotelians* imagine, that every ſeemingly ſimilar, or diſtinct ſubſtance, ſeparated from a body, by the help of the fire, was pre-exiſtent in that ſubſtance, as a principle. I do not mean, that any thing is ſeparable from a body by fire, that was not materially pre-exiſtent in it; for it far exceeds the power of meer natural agents, to produce a-new, ſo much as a ſingle atom of matter, which they can only modify and alter, not create.

Nor do I peremptorily deny, that ſome things obtain'd by the fire from a mix'd body, may have been more than barely materially pre-exiſtent in it; ſince there are concretes, which before being expos'd to the fire, ſhew they abound ſome with ſalt, and others with ſulphur. It will ſerve the preſent purpoſe, if it appear, that ſeveral things, obtain'd from a mix'd body, expos'd to the fire, were not its ingredients before; for then it will be rational to expect, that chymiſts may deceive themſelves and others, in concluding, reſolutely and univerſally, thoſe ſubſtances to be the elementary ingredients of bodies, barely ſeparated by the fire, of which it may yet be queſtion'd whether they exiſt or no; at leaſt till ſome other argument than that drawn from the analyſis, be produced to reſolve the doubt.

I ſay then, it may, without abſurdity, be doubted, whether the different ſubſtances obtainable from a concrete diſſipated by the fire, were exiſtent in it, in that form (at leaſt, as to their minute parts,) wherein we find them after the analyſis, ſo that the fire only disjoin'd and extricated the corpuſcles of one principle from thoſe of another, wherewith they before were blended.

That all compound bodies ſeem to differ only in ſome mechanical properties.

Upon this ſuppoſition, I ſhall endeavour to ſhew, firſt, that ſuch ſubſtances, as chymiſts call principles, may be produced *de novo*; and ſecondly, to make it probable, that by the fire we may actually obtain from ſome mix'd bodies ſuch ſubſtances, as were not, in the ſenſe deliver'd, pre-exiſtent in them.

Now, if it be true, as 'tis probable, that compound bodies differ from one another, in nothing but the various textures, reſulting from the magnitude, ſhape, motion, and arrangement of their ſmall parts, it will not be irrational to conceive, that one and the ſame parcel of univerſal matter, may, by various alterations and contextures, be brought to deſerve the name ſometimes of a ſulphureous, and ſometimes of a terreſtrial or aqueous body.

Argued from growth of plants.

About the beginning of *May*, I caus'd my gardener to dig out a convenient quantity of good earth, to dry it well in an oven, to weigh it, to put it in an earthen pot, almoſt level with the ſurface of the ground, and to ſet in it a particular ſeed of ſquaſh, or the *Indian* kind of pompion, of ſudden growth; this ſeed I order'd him to water only with rain or ſpring-water. 'Twas delightful to behold how faſt this grew, tho' unſeaſonably ſown; but the winter coming on, hinder'd it from attaining any thing of its due magnitude; which made me order it to be taken up about the middle of *October*. This being carefully done, it weigh'd with the ſtalk and leaves two pounds and three quarters; then the earth being baked as formerly, its weight was found the ſame as at firſt; and being ſet into the oven twice more, and weigh'd again, it ſhrunk little or nothing.

But I muſt not conceal, that in another experiment of this kind, the earth ſeem'd to have been much more waſted; yet here, as well as in the former trial, it appeared, that the main body of the plant, conſiſted of tranſmuted water. And I might add, that I caus'd the former experiment, with large pompions, to be repeated with ſo good ſucceſs, that it not only much ſurpaſs'd any I made before, but ſeem'd ſtrangely to conclude what I am pleading for. The like experiments may be as conveniently try'd with the ſeeds of any plant, whoſe growth is haſty, and its ſize large. If tobacco will thrive in theſe cold climates, in earth unmanured, it would not be amiſs to make a trial with it; for it is an annual plant, that riſes where it proſpers, ſometimes as high as a tall man; and I have had leaves of it in my garden, near a foot and a half broad. But the next time I make this experiment, it ſhall be with ſeveral ſeeds of the ſame ſort, in the ſame pot of earth; that ſo the event may be the more conſpicuous. But becauſe every body has not conveniency of time and place, for this experiment, I made ſome ſhorter, and more expeditious trials in my chamber. I took a top of ſpear-mint, about an inch long, and put it into a vial full of ſpring-water, ſo that the upper part of the mint reach'd above the neck of the glaſs, while the lower was immers'd in the water; within a few days, this mint began to ſhoot out roots into the water, to diſplay its leaves, and to aſpire upwards; and in a ſhort time, it had numerous roots and leaves, and theſe very ſtrong and fragrant of the odour of the mint; but the heat of my chamber, as I ſuppoſe, kill'd the plant, when it was grown to have a pretty thick ſtalk; which with the various and ramified roots it ſhot into the water, as if it had been earth, preſented a pleaſant ſpectacle. The like I have try'd with ſweet marjoram, and found the experiment ſucceed alſo, tho' ſomewhat more ſlowly with baulm and penniroyal, *&c.* And one of theſe vegetables, nouriſh'd only by water, having obtain'd a competent growth, I caus'd to be diſtill'd in a ſmall retort; and thereby obtain'd ſome phlegm, a little empyreumatical ſpirit, a ſmall quantity of aduſt oil, and a *Caput mortuum*, which appearing to be a coal, I concluded it to conſiſt of ſalt and earth; but the quantity of it was ſo ſmall, that I forbore to calcine it. The water uſed to nouriſh this plant, was not ſhifted, nor renewed; and I choſe ſpring-water, rather than rain-water, becauſe the latter is more diſcernably a kind of πανσπερμία, which, tho' free from groſſer mixtures, ſeems to contain in it, beſides the ſteams of ſeveral bodies wandering in the air, a certain ſpirituous ſubſtance, which may be extracted out of it; and is by ſome miſtaken for the ſpirit of the world embodied.

But *Helmont* avers, that he took 200 pounds of earth, dry'd in an oven; and having put it into an earthen veſſel, and moiſten'd it with rain-water, planted in it the trunk of a willow tree, of five pound weight; this he water'd, as occaſion requir'd, with rain, or with diſtill'd water; and to keep the adjacent earth from getting into the veſſel, he employed a perforated plate of iron. After five years he took out the tree, weigh'd it, and computing the leaves that fell in four autumns, he found it to weigh 169 pounds, and about three ounces. And having again dry'd the earth it grew in, he found it to want of its former weight of 200 pounds, only about two ounces; ſo that 164 pounds of the roots, wood, and bark, which conſtituted the tree, ſeem to have ſprung from the water. And, doubtleſs, if *Helmont* had made any analyſis of this plant, as I did of one of my plants, fed only with fair water, it would have afforded him the like diſtinct ſubſtances, as another vegetable of the ſame kind.

And water being the principle of all things.

Helmont, we know too, aſſerts, that all mix'd bodies ſpring from one element; and that vegetables, animals, marcaſites, ſtones, metals, *&c.* are materially but ſimple water, diſguiz'd into theſe various forms by the plaſtic virtue of their ſeeds; and his principal reaſons for it ſeem to be theſe. 1. The ultimate reduction of mixed bodies into inſipid water. 2. The viciſſitude of the ſuppoſed elements. And, 3. The production of perfectly mix'd bodies out of ſimple water. And, firſt, he affirms, that his alkaheſt adequately reſolves plants, animals, and minerals, into one liquor, or more, according to their ſeveral internal differences of parts; and that the alkaheſt being abſtracted from theſe liquors, in the ſame weight and with virtue, as when it diſſolv'd them, the liquors may, by frequent cohobations from chalk, or ſome other proper matter, be totally depriv'd of their ſeminal endowments, and return at laſt to their firſt matter, inſipid water. Other ways he alſo propoſes, to diveſt ſome particular bodies of their borrowed ſhapes, and make them return to their firſt ſimplicity. The ſecond topic whence *Helmont* argues water to be the material cauſe of mixed bodies, is, that the other ſuppoſed elements may be tranſmuted into one another. But the experiments he produces on this occaſion are ſo difficult to be made, and judg'd of, that I ſhall not inſiſt upon them. Beſides, if they were granted to be true, his inference from them is ſomewhat diſputable; and as our author in his firſt argument, endeavours to prove water the ſole element of mix'd bodies, by their ultimate reſolution, when by his alkaheſt, or ſome other conquering agent, the ſeeds have been worn out, or deſtroyed; which

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which diſguized them; ſo in his third argument, he attempts to ſhew the ſame by the conſtitution of bodies; which he aſſerts to be nothing but water ſubdued by ſeminal virtues. Of this he gives various inſtances, as to plants and animals; but ſeveral of them being difficult, either to be made or underſtood, and others of them liable to different exceptions; the inſtance of the willow-tree ſeems the moſt proper to inſiſt on. However, this opinion of his is no new one; tho' the arguments for it may, in great meaſure, be his own. The doctrine is aſcribed to *Thales*, to *Homer*, to *Heſiod*, to *Moſes*, and to the *Phenicians*, who taught, that the earth was made of water; and from them, 'tis ſuppoſed that *Thales* took it.

And tho' *Helmont* produces no inſtance of any mineral body, and ſcarce of any animal, generated of water; yet a *French* chymiſt, M. *de Rochas*, affords us an experiment, which, if it ſucceeded as he delivers it, is very remarkable. "Having," ſays he," found ſur-
" prizing things from the natural operation of water, I was willing
" to know what might be done with it by art. I therefore took
" water, which, I knew, was mixed with no other thing than the
" ſpirit of life; and by a heat artificial, continual, and proportionate,
" I prepared and diſpoſed it by the graduations of coagulation, con-
" gelation, and fixation, till it was turned into earth, which produced
" animals, vegetables, and minerals. I ſay not what animals, vegetables,
" and minerals, for that is reſerved for another occaſion; but the animals
" moved of themſelves, eat, *&c.* and by the anatomy I made of them,
" I found them compos'd of much ſulphur, little mercury, and leſs ſalt.
" The minerals began to grow and increaſe, by converting into their
" own nature one part of the earth thereto diſpoſed; they were ſolid and
" heavy. And by this truly demonſtrative ſcience, chymiſtry, I found
" that they were compoſed of much ſalt, little ſulphur, and leſs mercury."

But I have ſome ſuſpicions concerning this ſtrange relation, which make me unwilling to declare an opinion of it; unleſs I were ſatisfied in ſeveral material circumſtances, which our author has left unmentioned: tho' as for the generation of living creatures, both vegetable and ſenſitive, it need not ſeem incredible; ſince we find, that our common water, which is often impregnated with variety of ſeminal principles, long kept in a quiet place, will putrefie; and then too, perhaps, produce moſs and little worms, or other inſects, according to the nature of the ſeeds that were lurking in it. And as *Helmont* gives no inſtance of the production of minerals out of water; ſo the principal argument that he employs, to prove that they and other bodies may be reſolv'd into water, is drawn from the operations of his alkaheſt, and, conſequently, cannot be ſatisfactorily examined by us.

'Tis, however, ſurprizing to obſerve, how great a ſhare of water goes to make up ſeveral bodies, whoſe forms promiſe nothing near ſo much. Eels, by diſtillation, yielded me ſome oil, ſpirit, and volatile ſalt, beſides the *Caput mortuum*; yet all theſe were ſo diſproportionate to the phlegm, that they ſeemed to have been nothing but that coagulated; which, likewiſe, ſtrangely abounds in vipers, tho' they are eſteemed very hot in operation, and will, in a convenient air, ſurvive for ſome days the loſs of their heads and hearts. Human blood it ſelf, as ſpirituous and as elaborate a liquor as 'tis reputed, ſo abounds in phlegm, that diſtilling ſome of it, on purpoſe to try the experiment; out of about ſeven ounces and a half, we drew near ſix ounces of phlegm, before any of the more operative principles began to riſe. And, to ſatisfie my ſelf that ſome of theſe animal phlegms were ſufficiently deſtitute of ſpirit, to deſerve their name; I was not content to taſt them only, but poured on them acid liquors, to try if they contained any volatile ſalt or ſpirit; which would probably have diſcovered it ſelf, by making an ebullition with the liquor thus employed. And tho' corroſive ſpirits ſeem to be nothing elſe but fluid ſalts, yet they alſo abound in water; which may be obſerved, by entangling, and ſo fixing their ſaline part, as to make them corrode ſome proper body; or elſe if it be mortified with a contrary ſalt, as I have very manifeſtly obſerved, in making a medicine ſomewhat like ***Helmont***'s *Balſamus Samech*, with diſtill'd vinegar, inſtead of ſpirit of wine, wherewith he prepares it; for of that acid ſpirit, the ſalt of tartar, from which it is diſtill'd, will, by mortifying and retaining the acid ſalt, turn into worthleſs phlegm, near twenty times its weight, before it be ſo fully impregnated, as to rob no more diſtilled vinegar of its ſalt. And tho' ſpirit of wine, exquiſitely rectified, ſeems of all liquors to be the moſt free from water; yet even this is by ***Helmont***, in caſe what he relates is true, with probability, affirmed to be materially water, under a ſulphureous diſguize; for, according to him, in making that excellent medicine *Paracelſus*'s *Balſamus Samech*, (which is nothing but *Sal tartari* dulcifyed, by diſtilling ſpirit of wine from it, till the ſalt be ſufficiently ſaturated with its ſulphur; and till it ſuffers the liquor to be drawn off as ſtrong as it was poured on;) when the ſalt of tartar, from which it is diſtill'd, hath retained, or deprived it of the ſulphureous parts of the ſpirit of wine; the reſt, which is incomparably the greater part of the liquor, will turn to phlegm. But I have not as yet ſufficiently tried the thing my ſelf: however, ſomething of experiment keeps me from thinking it abſurd; tho' I in vain try'd it with ordinary ſalt of tartar: for ***Helmont*** not only often relates it, and draws conſequences from it, but a perſon noted for his veracity, and ſkill in chymiſtry, affirm'd to me, that by preparing the ſalt and ſpirit, in a way ſuitable to my principles, he had made the experiment ſucceed very well; without adding any thing to the ſalt and ſpirit.

I have indeed, ſometimes, wondered to ſee how much phlegm may be obtained from bodies by fire. But ſuppoſing the alkaheſt cou'd reduce all bodies into water; yet whether the water, becauſe inſipid, muſt be elementary, may be doubted: for I remember the candid *Petrus Laurembergius* affirms, he ſaw an inſipid menſtruum, that was a powerful diſſolvent, even of gold. And the water which may be drawn

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from quick-ſilver, without addition, tho' it be almoſt taſtleſs, appears of a different nature from ſimple water; eſpecially if appropriated minerals be therein digeſted. And farther, I ſee no neceſſity to conceive, that the water mentioned by *Moſes*, on which the ſpirit is ſaid to have brooded, as the univerſal matter, was ſimple and elementary water; ſince tho' we ſhou'd ſuppoſe it to have been an agitated congeries, conſiſting of a great variety of ſeminal principles, and of other corpuſcles fit to be ſubdued and faſhioned by them; it might yet be a body fluid, like water, in caſe the corpuſcles it was made up of were, by their creator, made ſmall enough, and put into ſuch an actual motion as might make them roll and glide over one another. And as we now ſay the ſea conſiſts of water, notwithſtanding the ſaline, terreſtrial, and other bodies mix'd with it; ſuch a liquor as the former may well be call'd water; becauſe that was the greateſt of unknown bodies whereto it was like. But that a body may be fluid enough to appear a liquor, and yet contain corpuſcles of a very different nature, appears from expoſing a quantity of vitriol in a ſtrong veſſel to a competent fire; for tho' it contains aqueous, earthy, ſaline, ſulphureous, and metalline parts; yet the whole maſs will at firſt be fluid, and boil like water.

But whether or no we conclude all things to have been generated of water, 'tis manifeſt, from what I have try'd, as to the growth of vegetables fed with water, that ſalt, ſpirit, earth, and even oil, may be produced out of water; and conſequently, that a chymical principle as well as a *Peripatetic* element, may, in ſome caſes, be generated anew, or obtain'd from ſuch a parcel of matter as was not before endow'd with the form of ſuch a principle or element.

The fire alſo compounds the parts of bodies after a new manner.

I ſhall next endeavour to ſhew, that the operation of the fire, ſometimes, not only actually divides mix'd bodies into ſmall parts, but compounds thoſe parts after a new manner; whence there may poſſibly reſult, as well ſaline and ſulphureous ſubſtances, as thoſe of different textures. And, perhaps, it will aſſiſt us in our inquiry into the effects of the operations of the fire upon other bodies, to conſider a little what it does to thoſe mixtures, which being the productions of art, we beſt know what enters their compoſition. Now, tho' ſope is made up of oil or greaſe, ſalt and water, well incorporated together; yet if you expoſe the maſs they conſtitute, to a gradual fire, in a retort, you will indeed make a ſeparation, tho' not of the ſame ſubſtances that were united into ſope; but of others of a different, and not an elementary nature; and eſpecially of an oil very ſharp, fetid, and remote in quality from that employ'd to make the ſope: ſo if you mix ſal-armoniac, in a due proportion, with quick-lime, and diſtil them by degrees of fire, you ſhall not divide the ſal-armoniac from the quick-lime; tho' the one be a volatile, and the other a fixed ſubſtance; but that which aſcends will be a ſpirit much more fugitive, piercing, and fetid, than ſal-armoniac; and there will remain with the quick-lime almoſt all the ſea-ſalt that concurr'd to compoſe the ſal-armoniac. And how well the ſea-ſalt was united to the lime, appears from hence, that I have, by making the fire at length very vehement, caus'd both the ingredients to melt, in the retort, into one maſs, apt to grow moiſt in a damp air. If it be here objected, that theſe inſtances are taken from factitious concretes, which are more compounded than natural ones; I reply, it will be difficult to prove, that nature her ſelf does not mix together ſuch bodies as are already compounded of elementary or more ſimple ones. Thus vitriol, for inſtance, tho' I have ſometimes taken it out of the mineral earths, where nature had, without the aſſiſtance of art, prepared it, is really a mix'd body, conſiſting of a terreſtrial ſubſtance of a metal, and alſo of at leaſt one ſaline body of a peculiar, and not elementary nature. And we ſee, alſo, in animals, that their blood may be compos'd of ſeveral very different mix'd bodies; ſince many ſea-fowl taſt rank of the fiſh on which they ordinarily feed. And *Hippocrates* obſerves, that a child may be purg'd by the milk of the nurſe, who has taken elaterium; which argues, that the purging corpuſcles of the medicament concur to make up the milk of the nurſe. And from many vegetables there may, without any addition, be obtain'd glaſs; a body ſurely not pre-exiſtent in them, but produced by the fire. I ſhall only add, that by a certain artificial way of managing quick-ſilver, I can, without addition, ſeparate from it a fourth part of a clear liquor, which, with an ordinary *Peripatetic*, wou'd paſs for water, and which a vulgar chymiſt wou'd take for phlegm; and this, for ought I have yet ſeen or heard, is not reducible into mercury again, and conſequently, is more than a diſguize of it. Now, beſides that ſeveral chymiſts will not allow mercury to have any conſiderable quanity of either of the ignoble ingredients, earth and water; the great ponderouſneſs of quick-ſilver makes it unlikely, that it can contain ſo much water as may thus be obtain'd from it; ſince mercury weighs fourteen times more than water of the ſame bulk. And two friends of mine, the one a phyſician, and the other a mathematician, both of them perſons of unſuſpected credit, have ſolemnly aſſured me, that, after many trials they made to reduce mercury into water, in order to a philoſophical work upon gold; they once, by ſeveral cohobations, reduced a pound of quick-ſilver into almoſt a pound of water; and this without the addition of any other ſubſtance, but only by urging the mercury with a fire, skilfully managed. Hence it ſufficiently appears, that the fire may ſometimes as well alter bodies as divide them; and that by its means, we may obtain from a mix'd body what did not pre-exiſt therein. And how are we ſure that phlegm is barely ſeparated, not produced, in other bodies by the action of fire; for, many other mix'd bodies are of a much leſs conſtant, and more alterable nature, than mercury appears to be? If we believe *Helmont*'s relations, the *tria prima*, or three chymical principles, are neither ingenerable, nor incorruptible ſubſtances; ſince by his alkaheſt, ſome of them may be produced of bodies that were before of another denomination, and all by the ſame powerful menſtruum, be reduced into inſipid water.

The nature of mixture conſidered.

But here may occur a ſcruple about the nature of mixture. *Ariſtotle*, we know, declares it to be ſuch a mutual penetration, and perfect union of the elements, that there is no portion of the mix'd body, how minute ſoever, which does not contain all and every of the four elements; or in which, all the elements are not. And I remember, he reprehends the mixture taught by the ancients, for too ſlight or groſs, as that wherein the elements were only blended, not united: the ancients, however, tho' they did not all agree what kind of bodies were mix'd; yet they almoſt unanimouſly held, that in a compounded body, tho' the *Miſcibilia* were aſſociated in ſuch ſmall parts, and with ſo much exactneſs, that there was no ſenſible particle of the maſs, but ſeem'd of the ſame nature with the reſt, and with the whole; but as to the inſenſible parcels of matter, whereof the *Miſcibilia* conſiſted, they were ſuppos'd to retain each of them its own nature, being but by appoſition united with the reſt, into one body. So that tho', by virtue of this compoſition, the mix'd bodies, perhaps, obtain'd ſeveral new qualities; ſtill the ingredients that compounded it, retaining their own nature, were, by the deſtruction of the compoſition, ſeparable from each other; the minute parts, diſengaged from thoſe of a different nature, and aſſociated with thoſe of their own ſort, returning to fire, earth, or water, as they were before they chanc'd to be ingredients of that compoſition. Thus in a piece of cloth, made of white and black threads interwoven, wherein, tho' the whole appear neither white nor black, but grey; yet each of the white and black threads, that compoſe it, remains what it was before, if they were pull'd aſunder, and ſorted, each colour by its ſelf.

Ariſtotle tells us, that if a drop of wine be put into ten thouſand meaſures of water, the wine being overpower'd by ſo vaſt a quantity of water, will be turn'd into it. But if this doctrine were true, one might hope, by melting a maſs of gold and ſilver, and by but caſting into it lead or antimony, grain after grain, we might, at pleaſure, within a reaſonable compaſs of time, turn what quantity we deſired of the ignoble, into the noble metals. Yet in that operation, which the refiners call quartation, and employ to purify gold, altho' three parts of ſilver be ſo exquiſitely mix'd, by fuſion, with a fourth part of gold, that the reſulting maſs acquires ſeveral new qualities, by virtue of the compoſition; and that there is ſcarce any ſenſible part of it which is not compos'd of both the metals; yet if this mixture be caſt into *Aqua fortis*, the ſilver will be diſſolved therein, and the gold, like a dark or black powder, will fall to the bottom; and either body may be again reduced into ſuch a metal, as it was before; which ſhews, that each retain'd its nature, notwithſtanding its being mix'd *per*

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minima, with the other. We likewiſe ſee, that tho' one part of pure ſilver, be mixed with ten parts, or more, of lead; yet the fire will, upon the cupel, eaſily and perfectly ſeparate them again. And not only in chymical analyſes, a ſeparation is made of the elementary ingredients, but ſome mixed bodies afford a much greater quantity of one particular principle than of another; as turpentine and amber yield much more oil and ſulphur, than water; whilſt wine, which is confeſs'd to be a perfectly mix'd body, affords but a little inflammable ſpirit or ſulphur, and not much more earth; but a vaſt proportion of phlegm, or water; which could not be, if, as the *Peripatetics* ſuppoſe, every minute particle were of the ſame nature with the whole; and, conſequently, contained earth and water, air and fire.

But not to conſider thoſe improper mixtures, wherein homogeneous bodies are join'd, as when water is mix'd with water; proper mixtures ſeem, in the general, to be but an intimate union of any two or more bodies, of different denominations; as when aſhes and ſand are fuſed into glaſs, or antimony and iron into *Regulus Martis*; when wine is ſhook with water, or ſugar diſſolv'd in the ſame. Now in this general notion of mixture, it does not appear, that the ingredients do, in their ſmall parts, ſo retain their nature, and remain diſtinct in the compound, that they may thence, by the fire, be again taken aſunder. For tho', perhaps, in ſome mixtures of certain permanent bodies, this recovery of the ſame ingredients may be made; yet I am not convinced, that it will generally hold, or that it is deducible from chymical experiments, and the true notion of mixture. But bodies, I preſume, may be mixed, and that very durably, tho' they are not elementary, nor have been reſolved into elements, or principles, in order to it; as is evident in the *Regulus* of fuſed antimony and iron; and in gold coin, which laſts for many ages, whilſt the gold is generally alloy'd by the mixture of a quantity of ſilver, or copper, or of both. And there being but one univerſal matter of all things, the portions of it ſeem to differ from one another, only in certain qualities, or accidents; upon whoſe account the corporeal ſubſtance they belong to, receives its denomination, and is referr'd to ſome particular ſort of bodies; ſo that if it be deprived of thoſe qualities, tho' it ceaſes not to be a body, yet it ceaſes from being that kind of body, as a plant, or an animal, a red, or a green, a ſweet, or a ſour ſubſtance. It alſo frequently happens, that the ſmall parts of bodies cohere together but by immediate contact and reſt; whilſt there are few bodies, whoſe minute parts ſtick ſo cloſe together, but that it is poſſible to meet with ſome other body, whoſe ſmall parts may get between them, and ſo disjoin them; or may be fitted to cohere more ſtrongly with ſome of them, than thoſe do with the reſt; or, at leaſt, may be combined ſo cloſely therewith, that neither the fire, nor the other uſual inſtruments of chymical analyſes, will ſeparate them. Theſe things conſidered, I cannot peremptorily deny, that there may be ſome ſmall maſſes, wherein the particles are ſo minute, and the coherence ſo ſtrict, or both, that when bodies of different denominations, and conſiſting of ſuch durable maſſes, happen to be mingled; tho' the compound body made up of them, may be very different from either of the ingredients, yet each of the little cluſters may ſo retain its own nature, as to be again ſeparable to what it was before. Thus when gold and ſilver are melted together in a due proportion, *Aqua fortis* will diſſolve the ſilver, and leave the gold untouch'd; by which means both the metals may be recover'd from the mixed maſs. There are other cluſters alſo, wherein the particles ſtick not ſo cloſe together, but they may meet with corpuſcles of another denomination, diſpos'd to be more cloſely united with ſome of them, than they were among themſelves; and in ſuch caſe, two corpuſcles thus combining, loſing that ſhape, ſize, motion, or other accident, upon whoſe account they exhibited ſuch a determinate quality, or nature; each of them really ceaſes to be a corpuſcle of the ſame denomination it was before; and from the coalition of theſe, there may reſult a new body, as really one as either of the corpuſcles, before they were confounded; for this concretion is really endowed with its own diſtinct qualities, and can no more, by the fire, nor any other known way of analyſis, be divided again into the corpuſcles, that at firſt concurr'd to make it, than either of them could, by the ſame means, be ſubdivided into other particles. Thus, by cryſtallizing a ſolution of copper in *Aqua fortis*, or ſpirit of nitre, you may obtain a good vitriol; which, tho', by virtue of the compoſition, it has manifeſtly ſeveral qualities not to be met with in either of the ingredients; yet it ſeems, that the nitrous ſpirits may, in this compound maſs, retain their former nature: for having diſtilled this vitriol, there came over plenty of red fumes; which, by that colour, by their peculiar ill ſcent, and by their ſourneſs, manifeſted themſelves to be nitrous ſpirits: and that the remaining calx continued copper, will be eaſily believed. But if you diſſolve minium, which is but lead powder'd by the fire, in good ſpirit of vinegar, and cryſtallize the ſolution; you ſhall not only have a saccharine ſalt, exceedingly different from both its ingredients; but the union of ſome parts of the menſtruum, with others of the metal, is ſo ſtrict, that the ſpirit of vinegar ſeems to be deſtroyed in that capacity; ſince the ſaline corpuſcles have quite loſt their acidity: nor can ſuch acid parts as were put to the minium, be ſeparated, by any known way, from the *Saccharum Saturni*, reſulting from them both; for there is no ſourneſs at all, but an admirable ſweetneſs to be taſted in the concretion. And not only ſpirit of wine, which, otherwiſe, will immediately hiſs when mingled with ſtrong ſpirit of vinegar, had no ſuch effect when poured upon *Saccharum Saturni*; wherein yet the acid ſalt of vinegar, did it ſurvive, may ſeem to be concentrated; but upon the diſtillation of *Saccharum*

Saturni by it ſelf, I found, indeed, a liquor very piercing, but not at all acid; and different as well in ſmell, and other qualities, as in taſt, from the ſpirit of vinegar; which, likewiſe, ſeem'd to have left ſome of its parts very firmly united to the *Caput mortuum:* and this, tho' of the nature of lead, was in ſmell, colour, *&c.* different from minium. Thus, alſo, tho' two powders, the one blue, and the other yellow, may appear a green mixture, whilſt neither of them loſes its own colour, as a good microſcope has ſometimes informed me; yet having mixed minium and ſal-armoniac in a due proportion, and expos'd them in a glaſs veſſel to the fire, the whole maſs became white, and the red corpuſcles were deſtroyed; for tho' the calcin'd lead was ſeparable from the ſalt, yet it did not part from it in the form of a red powder, ſuch as the minium was, when put to the ſal-armoniac: I leave it, alſo, to be conſidered, whether in blood, and ſeveral other bodies, it be probable, that each of the corpuſcles concurring to make up the compound, always retains its own nature therein; ſo that chymiſts may extricate each ſort of them from all the others, wherewith it contributed to compoſe a body of one denomination.

And ſince the major part of chymiſts allow, what thoſe they call philoſophers affirm of their ſtone; they may pleaſe to conſider, that tho' when common gold and lead are mixed together, the lead may be ſever'd almoſt unalter'd from the gold; yet if, inſtead of gold, a little of the red elixir be mixed with the lead, their union will be ſo indiſſoluble in the perfect gold produced thereby, that there is no known, nor, perhaps, poſſible way of ſeparating the diffus'd elixir from the fix'd lead; but they both conſtitute a moſt permanent body, wherein the lead ſeems quite to have loſt its properties; and to have been rather tranſmuted by the elixir, than aſſociated with it. Hence it ſeems not always neceſſary, that the bodies intimately mixed, ſhould each retain its own nature; ſo as, when the maſs it ſelf is diſſipated by the fire, to be more diſpoſed to appear again in its priſtine form, than in a new one; which it may have acquired by a ſtricter aſſociation of its parts, with thoſe of ſome of the other ingredients of the compoſition, than with one another.

If it be objected, that unleſs the hypotheſis I oppoſe, be admitted, in ſuch caſes as we have mentioned, there would not be an union, but a deſtruction of the mix'd bodies; which ſeems all one as to ſay, that of ſuch bodies there is no mixture at all: I anſwer, that tho' the mix'd ſubſtances remain, whilſt only their accidents are deſtroyed; and tho' we may call them ingredients, becauſe they were diſtinct bodies before they were put together; yet they are afterwards ſo confounded, that I ſhall rather call them concretions, or reſulting bodies, than mix'd ones.

If it be alſo ſaid, that this notion of mixture, tho' it may be allow'd when bodies already compounded are put to be mix'd; yet it is not applicable to thoſe mixtures, that are immediately made of the elements,

ments, or principles themſelves: I reply, that I here conſider the nature of mixture, ſomewhat more generally than the chymiſts; who yet cannot deny, that there often are mixtures, and thoſe very durable ones, made of bodies not elementary. And farther; tho' it may be probably pretended, that in thoſe mixtures, made immediately of the bodies called principles or elements, the mix'd ingredients may better retain their own nature in the compound maſs, and be more eaſily ſeparated from thence; yet beſides that it may be doubted, whether there are any ſuch primary bodies, I ſee not why the reaſon I alledg'd, of the deſtructibility of the ingredients of bodies in general, may not, ſometimes, be applicable to ſalt, ſulphur, or mercury; till it be ſhewn upon what account we are to own them priviledg'd.

But to return from whence this conſideration of mixture has carry'd us. We have ſeen, by the different ſubſtances obtained from a plant, *&c.* nouriſhed only with water, that it was not neceſſary nature ſhould always compound a body originally, of all ſuch different bodies, as the fire could afterwards make it afford. But this is not all that may be collected from thoſe experiments. There ſeems, alſo, ſomething deducible from them, that ſubverts another foundation of the chymical doctrine. For ſince out of fair water alone, not only ſpirit, but ſalt, oil, and earth, may be produced, it follows, that ſalt and ſulphur are not primogeneal bodies and principles; ſince they are every day made out of plain water, by the texture which the ſeed, or ſeminal principle of plants, gives it. And this would not, perhaps, ſeem ſo ſtrange, did we not overlook the obvious and familiar operations of nature; for if we conſider what ſlight qualities they are that ſerve to denominate one of the *tria prima*; we ſhall find that nature frequently produces as great alterations in ſeveral parcels of matter. To be readily diſſoluble in water, is enough to make a body paſs for a ſalt; yet I ſee not why, from a new arrangement and diſpoſition of the component particles, it ſhould be much harder for nature to compoſe a body diſſoluble in water, of a portion of matter that was not ſo before; than of the liquid ſubſtance of an egg, which will eaſily mix with water, to produce, by the bare warmth of the brooding hen, membranes, feathers, tendons, *&c.* not diſſoluble in water. Nor is the hardneſs and brittleneſs of ſalt, more difficult for nature to introduce into ſuch a yeilding body as water, than it is for her to form the bones of a chick, out of the tender ſubſtance of the liquors of an egg. But I eaſily foreſee it will be alledg'd, that the former examples are all taken from plants and animals, wherein the matter is faſhioned by the plaſtic power of the ſeed, or ſomething analogous thereto; whereas the fire does not act like any of the ſeminal principles, but deſtroys them all, when they come within its reach. To this I need only ſay, that whether it be a ſeminal principle, or any other, which faſhions the matter, after thoſe various manners I have mention'd; 'tis evident, that either by the plaſtic power alone, or that and heat together, or by ſome other cauſe, capable of giving a texture to the matter; it is yet poſſible that it may be a-new contriv'd into ſuch bodies.

And thus much, I preſume, will ſuffice to ſhew, that a conſidering man may very well queſtion the truth of thoſe ſuppoſitions which chymiſts and the *Peripatetics*, without proof, take for granted; and upon which depends the validity of the inferences they draw from their experiments.

SECT. III.

I Proceed now to conſider the experiments themſelves, wherein our opponents uſually triumph and glory. And theſe will the rather deſerve a ſerious examination; becauſe thoſe who alledge them, do it with ſo much confidence and oſtentation, that they have hitherto impos'd upon almoſt all perſons, without excepting philoſophers and phyſicians themſelves, who have read their books, or heard them talk. For ſome learned men have been content rather to believe what theſe ſo boldly affirm, than be at the trouble and charge to try whether it were true or no. Others again, who have curioſity enough to examine the truth of what is averr'd, want ſkill and opportunity to do what they deſire; whilſt the generality, even of ſenſible men, ſeeing the chymiſts actually perform many ſtrange things, and, among others, reſolve compound bodies into ſeveral ſubſtances, not known by former philoſophers to be contained in them; and hearing with what confidence chymiſts aver the ſubſtances, thus obtain'd from compound bodies, by the fire, to be true elements or hypoſtatical principles of them, they are forward to think it but juſt to credit the ſkilful artiſts in their own art; eſpecially when thoſe things, whoſe nature they ſo confidently take upon them to teach others, are productions of their own ſkill, and ſuch as others know not what to make of.

But we muſt not ſuffer our ſelves to be impos'd upon by hard names or bold aſſertions; nor to be dazled with that light which ſhou'd but aſſiſt us to diſcern things the more clearly. To help in the production of bodies, is not to underſtand by them. Thus men, for being fathers of children, are not the better acquainted with the number and nature of the parts that conſtitute a child's body.

No preciſe number of elements fixt.

It does not appear, that three is preciſely and univerſally the number of the diſtinct ſubſtances or elements, into which all mix'd bodies are reſoluble by fire.

If it be granted, that the elements, at firſt, conſiſted of certain ſmall primary coalitions of the minute particles of matter into corpuſcles, very numerous, and very like each other; it will not be abſurd to con-

Chymiſtry.

conceive, that ſuch primary maſſes may be of far more ſorts than three or five; and conſequently we need not ſuppoſe, that in every compound body there ſhou'd be found juſt three ſorts of ſuch primitive coalitions.

And if, according to this notion, we allow a conſiderable number of different elements; it ſeems very poſſible, that to the conſtitution of one ſort of mix'd bodies, two kinds of elementary ones may ſuffice; as we lately ſaw in that moſt durable ſubſtance, glaſs; that another ſort of mix'd bodies may be compos'd of three elements, another of four, another of five, *&c.* ſo that upon this ſuppoſition, there can be no determinate number of elements aſſign'd; it being very probable, that ſome concretes conſiſt of fewer, ſome of more. Nay, it does not ſeem impoſſible, according to theſe principles, that there may be two ſorts of mix'd bodies; the one whereof may have none of the ſame elements the other conſiſts of; as we often ſee, two words, whereof the one has not any any of the letters to be met with in the other; or as happens in electuaries, wherein no ingredient, except ſugar, is common to any two of them.

And ſince it appears, from the permanency of gold and ſilver, that even corpuſcles, not of an elementary, but compound nature, may be of ſo durable a texture, as to remain indiſſoluble in the ordinary analyſis, that chymiſts make of bodies by the fire; 'tis not impoſſible, that tho' there were but three elements, yet there may be a greater number of bodies, which the uſual analyſis will not diſcover to be elementary.

It does not, indeed, ſufficiently appear from the common chymical experiments, that there is any one determinate number of elements to be uniformly met with, in all the ſeveral ſorts of bodies allow'd to be perfectly mix'd.

There are ſeveral bodies, which I cou'd never ſee divided, by fire, into ſo many as three elementary ſubſtances. I would fain ſee that fix'd and noble metal, gold, ſeparated into ſalt, ſulphur, and mercury; and if any man will ſubmit to a competent forfeiture, in caſe of failing, I ſhall willingly, if he ſucceeds, pay for both the materials and bear the charges of ſuch an experiment. I do not, indeed, after what I have try'd my ſelf, peremptorily deny, that there may, out of gold, be extracted a certain ſubſtance, which chymiſts call its tincture, or ſulphur; and which deprives the remaining body of its uſual colour. Nor am I ſure, that there cannot be drawn, out of the ſame metal, a real quick and running mercury. But for the ſalt of gold, I never could either ſee it, or be ſatisfied, by the relation of any credible eye-witneſs, that there was ſuch a thing ſeparated. And for the ſeveral proceſſes, which promiſe that effect, the materials to be wrought upon are ſomewhat too precious and coſtly to waſt upon adventures, whereof not only the ſucceſs is doubtful, but the very poſſibility not hitherto demonſtrated. Yet that which moſt deters me from ſuch

try,

tryals is, not that they are chargeable, but unſatisfactory, tho' they ſhould ſucceed. For the extraction of this golden ſalt, being, in chymical proceſſes, preſcribed to be obtain'd by corroſive menſtrua, or the intervention of other ſaline bodies; it will remain doubtful, whether the ſalt produc'd be that of gold it ſelf, or of the ſaline bodies or ſpirits, employed to prepare it; for that ſuch diſguizes of metals often impoſe upon artiſts, is no new thing in chymiſtry. I would, likewiſe, willingly ſee the three principles ſeparated from the pure ſort of virgin-ſand, from oſteocolla, from refined ſilver, from pure quick-ſilver, and from *Venetian* talc; which latter, by long detention in an extreme reverberatory heat, I cou'd but divide into ſmaller particles, not the conſtituent principles. Nay, when I caus'd it to be very long kept in a glaſs-houſe fire, it came out in the figure its lumps had, when put in; tho' alter'd to an almoſt amethyſtine colour. I dare not, indeed, abſolutely affirm it impoſſible to analyze theſe bodies into their *tria prima*; yet becauſe neither my own experiments, nor any competent teſtimony hath hitherto either taught me how ſuch an analyſis may be, or ſatisfied me that it hath been made; I muſt take the liberty to doubt, till the chymiſts prove it, or give us intelligible and practicable proceſſes to perform what they pretend. For whilſt they affect that enigmatical obſcurity, with which they puzzle the readers of their proceſſes, concerning the analytical preparation of gold or mercury; they leave wary perſons much unſatisfied, whether or no the different ſubſtances, they promiſe to produce, be truly the hypoſtatical principle, or only ſome intermixtures of the divided bodies, with thoſe employ'd to work upon them; as is evident in the ſeeming cryſtals of ſilver, and thoſe of mercury; which, tho' by ſome, inconſiderately ſuppoſed to be the ſalts of thoſe metals, are plainly but mixtures of the metalline bodies, with the ſaline parts of *Aqua fortis*, or other corroſive liquors; as is evident by their being reducible into what they were before.

And I cannot but confeſs, I have often wonder'd that chymiſts ſhould ſo confidently pretend to reſolve all metalline and other mineral bodies into ſalt, ſulphur, and mercury. For 'tis a ſaying almoſt proverbial among the adept; and the famous *Roger Bacon* has particularly adopted it; that 'tis eaſier to make gold, than to deſtroy it. And I fear that gold is not the only mineral from which chymiſts, in vain, attempt to ſeparate their three principles. I know, indeed, the learned *Sennertus* ſays, "there is ſalt and ſulphur contain'd in all mix'd bodies; and 'tis well known that ſkilful chymiſts can extract them thence;" but, by his favour, I muſt ſee very good proof, before I can believe ſuch bold general aſſertions: and he who wou'd convince me of their truth, muſt firſt teach me ſome real practicable way of ſeparating ſalt and ſulphur from gold, ſilver, and thoſe many different ſorts of ſtones, that a violent fire brings to fuſion. And not only I, for my own part, never ſaw any of the bodies, juſt mention'd, ſo re-

reſolv'd; but *Helmont* himſelf declares the ſame of ſand, flint, and ſome ſtones. Nay, *Quercetan*, tho' a grand ſtickler for the *tria prima*, confeſſes, that diamonds are irreſoluble And as for metalline mercuries, I remember a famous and ingenious artiſt, who had long been chymiſt to a great monarch, aſſured me, he had never really extracted a true and running mercury out of metals; nor had ſeen it done by any man elſe. And tho' gold is of all metals that whoſe mercury the chymiſts have moſt endeavoured to extract, and which they the moſt boaſt themſelves to have extracted; yet the experienced *Angelus Sala* avers the thing impoſſible: he adds, that himſelf had ſeen much labour in vain beſtowed upon that deſign; and that he had often ſeen the tricks and impoſtures of cheating alchymiſts detected in this affair. But the greateſt part of thoſe who are fond of ſuch *Charlatans*, being unskilful, or credulous, or both; 'tis very eaſy for ſuch as have ſome skill, much craft, more boldneſs, and no conſcience, to impoſe upon them; and, therefore, tho' many profeſs'd chymiſts, and perſons of quality, have told me, that they have made, or ſeen the mercury of gold, or of ſome other metal; yet I have been ſtill apt to fear, that either theſe perſons have had a deſign to deceive others, or have not had skill and circumſpection enough to keep themſelves from being deceived.

To make a ſhew of producing a metalline mercury.

I once deviſed an experiment, innocently to deceive ſome perſons, and let them ſee how little is to be built upon the affirmation of thoſe, who are either unskilful, or unwary, when they tell us, they have ſeen chymiſts make the mercury of a metal: and to render this the more evident, I made my experiment much more ſlight, ſhort, and ſimple, than are the chymiſts uſual proceſſes to extract metalline mercuries; their operations being commonly more elaborate and intricate, and by requiring a much longer time, give the alchymiſt a greater opportunity to cozen. And, to make my experiment look the more like a true analyſis, I not only pretend, as well as others, to extract a mercury from the metal I work upon; but likewiſe to ſeparate a large proportion of manifeſt and inflammable ſulphur. I take, then, the filings of copper, common ſublimate powder'd, and ſal-armoniac, of each about a dram or two; and theſe being well mix'd together, I put them into a glaſs urinal; which (having firſt ſtopp'd it with cotton) to avoid the noxious fumes, I approach, by degrees, to a competent fire of well-kindled coals, or to the flame of a candle; and, after a while, the bottom of the glaſs being held juſt upon the kindled coals, or in the flame; you may, in about a quarter of an hour, or leſs, perceive in the bottom of the glaſs ſome running mercury; and if you then take away the glaſs, and break it, you ſhall find a parcel of quick-ſilver, perhaps altogether, or perhaps part of it only, in the pores of the ſolid maſs. You will find too, that the remaining lump being held to the flame of the candle, will readily burn with a greeniſh flame, and ſoon after acquire in the air a greeniſh blue; which being the colour aſcribed to copper, when its body is unlock'd, 'tis eaſy to perſuade men, that this is the true ſulphur of that metal; eſpecially ſince not only the ſalts may be ſuppos'd to be flown away, or ſublimed to the upper part of the glaſs, whoſe inſide will commonly appear whitened by them; but the metal ſeems to be quite deſtroyed; the copper no longer appearing in a metalline form, but almoſt in that of a reſinous lump. The caſe, however, is only this; the ſaline parts of the ſublimate, together with the ſal-armoniac, excited and actuated by the vehement heat, fall upon the copper, whereby the ſmall parts of the mercury being freed from the ſalts that kept them aſunder, and by the heat toſs'd up and down, convene, after many occurſions, into a conſpicuous maſs of liquor: and as for the ſalts, ſome of the more volatile of them ſubliming, the others corrode the copper, and uniting themſelves with it, ſtrangely alter, and diſguize its metalline form, and therewith compoſe a new kind of concrete, inflammable like ſulphur.

More than three principles afforded by ſome bodies.

But to proceed; as there are ſome bodies which yield not ſo many as three principles; ſo there are many others, that, in their reſolution, exhibit more. From our doctrine of the primary aſſociation of the ſmall particles of matter, it ſeems probable, that of ſuch elementary corpuſcles, there may be more ſorts than three, or four, or five. And if corpuſcles of a compound nature, may, in all the uſual examples of chymiſts, paſs for elementary; it ſeems not impoſſible, that as *Aqua fortis*, or *Aqua regia*, will make a ſeparation of diſſolv'd ſilver and gold, tho' the fire cannot; ſo there may be ſome agent found ſo ſubtile and powerful, at leaſt in reſpect of thoſe particular compound corpuſcles, as to be able to reſolve them into the more ſimple ones, whereof they conſiſt; and, conſequently, increaſe the number of the diſtinct ſubſtances, whereinto the mixed body has been hitherto thought reſoluble. And if that be true we formerly mention'd, of *Helmont*'s alkaheſt, which divides bodies into other diſtinct ſubſtances, both as to number and nature, than doth the fire; it will greatly countenance my conjecture. But confining our ſelves to ſuch ways of analyzing mix'd bodies, as are already known to chymiſts; it may, without abſurdity, be queſtion'd, whether, beſides thoſe groſſer elements of bodies, which they call ſalt, ſulphur, and mercury, there may not be ingredients of a more ſubtile nature; which being extremely ſmall, and not in themſelves viſible, may eſcape unheeded, at the junctures of the veſſels employed in diſtillation. For we may well ſuſpect there are ſeveral ſorts of bodies, not immediate objects of any of our ſenſes; ſince we ſee, that not only thoſe little corpuſcles, which iſſue out of the load-ſtone, produce ſurprizing effects; but the effluvia of amber, jet, and other electrical concretes, tho', by their operations upon the particular bodies, diſpos'd to receive their action, they ſeem to fall under the cognizance of our ſight, yet do they not any way, as electrical, immediately affect us.

But to conſider only the ſenſible ingredients of mixed bodies; it ſeems queſtionable, whether from grapes variouſly order'd, there may not be drawn more diſtinct ſubſtances by the help of the fire, than from moſt other mixed bodies; for the grapes themſelves being dry'd into raiſins, and diſtill'd, will, beſides alkali, phlegm, and earth, yield a conſiderable quantity of an empyreumatical oil, and a ſpirit of a very different nature from that of wine: the unfermented juice of grapes, alſo, affords other liquors by diſtillation, than wine doth. The ſame juice, after fermentation, yields an inflammable ſpirit; which, if competently rectified, will burn entirely away. The ſame fermented juice degenerating into vinegar, yields an acid and corroding ſpirit; and tunned up, it arms it ſelf with tartar, out of which may be ſeparated, as out of other bodies, phlegm, ſpirit, oil, ſalt, and earth: not to mention what ſubſtances may be drawn from the vine it ſelf, probably different from thoſe which are ſeparated from tartar, which is a body of a particular kind. What force ſoever this inſtance be allow'd, towards proving that ſome bodies yield more elements than others; it can ſcarce be deny'd, that the major part of the bodies, diviſible into elements, afford more than three. For, beſides thoſe which the chymiſts name hypoſtatical, moſt bodies contain two others, phlegm and earth; which concurring, as well as the reſt, to the conſtitution of mixed bodies, and being as generally, if not more, found in their analyſis; I ſee no ſufficient cauſe, why they ſhould be excluded from the number of elements. Nor will it ſuffice to object, with the *Paracelſians*, that the *tria prima* are the moſt uſeful elements; and the earth and water but worthleſs and unactive: for elements being call'd ſo in relation to the conſtitution of mixed bodies; it ſhould be upon the account of its proving an ingredient, not on account of its uſe, that any thing is affirmed, or deny'd to be an element. And as for the pretended uſeleſſneſs of earth and water, it ſhould be conſider'd, that uſefulneſs, or the want of it, denotes only a reſpect, or relation to us; and, therefore, the preſence, or abſence of it, alters not the intrinſic nature of the thing. The noxious teeth of vipers are, for ought I know, uſeleſs to us; yet are acknowledged parts of their bodies: and it were hard to ſhew, of what greater uſe to us than phlegm or earth, are thoſe undiſcern'd ſtars, which our teleſcopes diſcover; yet we cannot but acknowledge them conſtituent, and conſiderable parts of the univerſe. However, the phlegm and earth are neceſſary to conſtitute the body whence they are ſeparated; and, conſequently, if that body be not uſeleſs to us, thoſe conſtituent parts, without which it could not have been that body, may be ſaid to be uſeful to us; and tho' the earth and water be not ſo conſpicuouſly operative, as the other three principles; yet, in this caſe, it will not be amiſs to remember the fable of the dangerous ſedition of the hands and legs, and other more buſie parts of the body, againſt the ſeemingly unactive ſtomach. In a word, ſince earth and water appear as clearly and as generally as the other principles, upon the reſolution of bodies, to be ingredients therein; and ſince they are uſeful, if not immediately to us, to the bodies they conſtitute; to exclude them out of the number of elements, is not to imitate nature.

Earth and water to be reckoned among the chymical principles.

And here I cannot but take notice, that the great argument which the chymiſts employ to debaſe earth and water, and make them look'd upon as uſeleſs and unworthy to be reckon'd among the principles of mix'd bodies, is, that they are not endowed with ſpecific properties, but only with elementary qualities; of which they ſpeak very ſlightly, as of qualities contemptible and unactive: but I ſee no ſufficient reaſon for this practice; ſince heat is confeſs'd to be an elementary quality; for, that numerous conſiderable things are performed by it, is manifeſt to thoſe who duly conſider the various phenomena, wherein it intervenes as a principal actor: and almoſt all the operations and productions of chymiſts are perform'd and obtain'd chiefly by its means. And as for cold it ſelf, upon whoſe account they ſo deſpiſe the earth and water; if they pleaſe to read in the hiſtory of the voyages of our *Engliſh* and *Dutch* navigators to *Nova Zembla*, and other northern regions, what ſtupendous things may be effected by cold; they would not, perhaps, think it ſo deſpicable. The conſervation of the texture of many bodies, both animate and inanimate, ſo greatly depends upon the convenient motion, both of their own fluid and looſer parts, and of the bodies which ſurround them, that we ſee not only the animal œconomy frequently diſordered by the immoderate or unſeaſonable coldneſs of the air; but the ſolid and durable body of iron it ſelf; for if you take a ſlender piece of ſteel, and after having brought it in the fire to a white heat, ſuffer it afterwards to cool leiſurely in the air, it will, when cold, be much of the ſame hardneſs it was of before; but if, as ſoon as you remove it from the fire, you plunge it into cold water, it will, upon the ſudden refrigeration, acquire a much greater hardneſs, and become manifeſtly brittle. And to ſhew, that this is not owing to any peculiar quality in the water, or other liquor, or unctuous matter, wherein ſuch heated ſteel is uſually quenched, that it may be temper'd; I know a very ſkilful tradeſman who frequently harden'd ſteel, by ſuddenly cooling it in a body that is neither a liquor, nor ſo much as moiſt. Hence it appears, that water is not always ſo inefficacious and contemptible a body as our chymiſts would have it paſs for.

And at leaſt one certain alkaline, if not alſo an acid, ſpirit.

But tho' I think it evident, that earth and phlegm are to be reckon'd among the elements of moſt animal and vegetable bodies; yet it is not upon this account that I ſuppoſe ſeveral bodies reſoluble into more ſubſtances than three. For there are two experiments, which I have ſometimes made, to ſhew, that, at leaſt, ſome mix'd bodies are di-

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diviſible into more diſtinct ſubſtances than five. Out of two diſtill'd liquors, which paſs for elements of the body, whence they are drawn. I can, without addition, make a true yellow and inflammable ſulphur, tho' the two liquors remain afterwards diſtinct; and having long obſerved, that by the diſtillation of ſeveral woods, both in ordinary and in ſome unuſual ſorts of veſſels, the ſpirits that came over, in plenty, had, beſides a ſtrong taſt, to be met with in the empyreumatical ſpirits of many other bodies, an acidity almoſt like that of vinegar; I ſuſpected, that tho' the ſouriſh liquor, diſtill'd from box-wood, for inſtance, be look'd upon by chymiſts as barely the ſpirit of it; and therefore as one ſingle element or principle, does yet really conſiſt of two different ſubſtances, and may be divided into them; and conſequently, that ſuch wood, and other mix'd bodies as abound with ſuch a vinegar, may be ſaid to conſiſt of one element or principle more than the chymiſts are yet aware of. I, therefore, diſtilled a quantity of box-wood *per ſe*, and ſlowly rectified the ſouriſh ſpirit, the better to free it both from oil and phlegm; then caſt into this rectified liquor a convenient quantity of powder'd coral, expecting that the acid part of the liquor wou'd corrode it, and being aſſociated therewith, be ſo retained by it, that the part of the liquor, which was not of an acid nature, nor fit to faſten upon the coral, would be permitted to aſcend alone. And, accordingly, having gently abſtracted the liquor from the coral, there came over a ſpirit of a ſtrong ſmell, and of a very piercing taſt, but without any ſourneſs; and which was, in ſeveral qualities, manifeſtly different, not only from a ſpirit of vinegar, but from ſome ſpirit of the ſame wood, that I purpoſely kept by me, without depriving it of its acid ingredient. This ſour ſpirit of box would not only, as I juſt ſaid, diſſolve corals, which the other would not faſten on; but being poured upon ſalt of tartar, would immediately boil and hiſs, tho' the other would lie quietly upon it. The acid ſpirit poured upon minium, made a ſugar of lead, which I did not find the other to do; ſome drops of this penetrating ſpirit being poured upon a few drops of ſyrup of violets, ſeem'd rather to dilute than otherwiſe alter the colour; whereas the acid ſpirit turn'd the ſyrup reddiſh, and wou'd probably have made it of as pure a red as acid ſalts uſually do, had not the operation been hinder'd by the other ſpirit. A few drops of the compound ſpirit, ſhaken into a large quantity of the infuſion of *Lignum nephriticum*, preſently deſtroy'd all its bluiſh colour; whilſt the other ſpirit wou'd ſuffer it to remain: and having pour'd fair water upon the coral that remain'd in the bottom of the glaſs, wherein I had rectified the double ſpirit, firſt drawn from the box; I found that the acid ſpirit had really diſſolv'd and coagulated with the coral. For by the effuſion of fair water, I obtain'd a ſolution, which was red; whence the water being evaporated, there remain'd a ſoluble ſubſtance much like the ſalt of coral; as chymiſts call that magiſtery of it, which they make by diſſolving it in common ſpirit of vinegar, and abſtracting the menſtruum *ad ſiccitatem*. The ſimple ſpirit of box, if chymiſts will have it therefore ſaline, becauſe it has a ſtrong taſt, furniſhes us with a new kind of ſaline bodies, different from thoſe hitherto taken notice of. For tho' of the three chief ſorts of ſalts, the acid, the alkaline, and the ſulphureous, there is no one that ſeems to be at amity with both the other two; yet I did not find but that the ſimple ſpirit of box agreed very well both with the acid and other ſalts. For tho' it wou'd lie very quiet with ſalt of tartar, ſpirit of urine, and other bodies, whoſe ſalts were either of an alkaline or fugitive nature; yet did not oil of vitriol it ſelf produce any hiſſing or efferveſcence with it.

This experiment teaches us a method whereby we may prepare a various ſorts of new ſpirits, which, tho' more ſimple than any ſuppoſed elementary, are manifeſtly endowed with peculiar and powerful qualities; ſome of which may, probably, be of conſiderable uſe in phyſic, as well alone, as aſſociated with other things; as may be gueſſed by the redneſs of that ſolution, the ſour ſpirit made of coral, *&c.* and, perhaps, we may here, with the ſame ſucceſs, uſe other alkaline bodies, inſtead of coral. From hence, however, I infer, that there are many compound bodies which may be reſolved into four ſuch different ſubſtances, which merit the name of principles, as well as thoſe to which the chymiſts freely allow it. For ſince they ſcruple not to reckon, that which I call the compound ſpirit of box, for the ſpirit; or as others would have it, the mercury of that wood; I ſee not why the acid liquor, and the other, ſhou'd not each of them, eſpecially the latter, be look'd upon as more deſerving to be called an elementary principle; ſince it muſt needs be of a more ſimple nature than the liquor which was found to be diviſible into that and the acid ſpirit. This further uſe may be alſo made of our experiment; to give us a ſuſpicion, that ſince a liquor, reputed by the chymiſts to be, without diſpute, homogeneous, is, by ſo ſlight a way, diviſible into two diſtinct and more ſimple ingredients; ſome more ſkilful or happier expedient may be found, either further to divide one of theſe ſpirits, or to reſolve ſome, at leaſt, of thoſe other ingredients of mixed bodies, that have hitherto paſs'd, among chymiſts, for their elements and principles.

SECT. IV.

The ambiguity of chymical writers conſider'd.

HAVING thus diſpatch'd what we had to ſay, as to the number of the diſtinct ſubſtances ſeparable from mixed bodies by the fire, I come to conſider the nature of them; and to ſhew, that tho' they ſeem homogeneous bodies, yet they have not the purity and ſim-

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ſimplicity that is requiſite in elements. But the confidence wherewith chymiſts call each of theſe ſubſtances by the name of ſalt, ſulphur, or mercury, and the intolerable ambiguity they allow themſelves in their writings, make it here neceſſary to complain of their unreaſonable practice of playing with words. Several authors among them, will often give many names to one thing; and ſome of theſe ſhall, perhaps, be ſuch, as much more properly ſignifie ſome diſtinct body of another kind: nay, even in technical words, or terms of art, they refrain not from this liberty; but will, as we obſerv'd, call the ſame ſubſtance ſometimes the ſulphur, and ſometimes the mercury of a body. The deſcriptions they give us of mercury, as of a principle, or ingredient of mix'd bodies, are ſo intricate, that even thoſe who have endeavoured to poliſh and illuſtrate the notions of the chymiſts, are reduced to confeſs, they know not what to make of it.

But whatever theſe men may promiſe themſelves from a canting way of delivering the principles of nature; they will find the major part of knowing perſons ſo vain, as, when they underſtand not what they read, to conclude, that it is rather the writer's fault, than their own. And thoſe who are ſo ambitious to be admir'd by the vulgar and ignorant, that rather than go without their applauſe, will expoſe themſelves to the contempt of the learned; ſhall, by my conſent, freely enjoy their option. As for the ſcruple of the myſtical writers to communicate their knowledge, they might, leſs to their own diſparagement, and to the trouble of their readers, have conceal'd it, by writing no books, than by writing bad ones. It were a temptation to ſay, that the chymiſts write thus darkly, not becauſe they think their notions too precious to be explain'd; but becauſe they fear, if they were explain'd, men would diſcern them to be vain and frivolous. And, indeed, I fear, that the chief reaſon why chymiſts have written ſo obſcurely of their three principles, may be, that not having clear and diſtinct notions of the matter themſelves, they cannot write otherwiſe than confuſedly about it: not to mention that ſeveral of them, conſcious of the invalidity of their doctrine, might well diſcern, that they could ſcarce avoid a confutation, but by keeping themſelves from being clearly underſtood. But tho' much may be ſaid to excuſe the chymiſts, when they write darkly and enigmatically about the preparation of their elixir, and ſome few other grand *Arcana*; yet when they pretend to teach the general principles of natural philoſophy, this equivocal way of writing is not to be endured. For in ſuch ſpeculative enquiries, wherein the naked knowledge of the truth is the thing principally aim'd at, what does he teach me worth thanks, who does not, if he can, make his notions intelligible to me; but by myſtical terms, and ambiguous phraſes, darkens what he ſhould clear up? And if the matter of the philoſopher's ſtone, and the manner of preparing

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Bodies ſeemingly homogeneous, not elementary. However, that which I am now entering upon, being the conſideration of the things themſelves, into which chymiſts reſolve mixed bodies by the fire; if I can ſhew that theſe are not of an elementary nature, it will be no great matter what names particular chymiſts have been pleas'd to give them.

I ſay then, that as generally as chymiſts appeal to experience, and as confidently as they alledge the ſeveral ſubſtances ſeparated by the fire from a mixed body, for a ſufficient proof of their being its component elements; yet thoſe different ſubſtances are, many of them, far from an elementary ſimplicity, and may be ſtill look'd upon as mixed bodies: the greater part of them alſo retaining the nature of thoſe concretes, whence they were forced.

But before I deſcend to particulars, I think it convenient to obſerve, firſt, that *Helmont* mentions it as a notable thing; and I take it to be a very conſiderable one; that tho' the diſtill'd oil of oil-olive, drawn *per ſe*, is, as I have try'd, of a very ſharp and fretting quality, and of an odious taſt; he tells us, that ſimple oil being only digeſted with *Paracelſus*'s *Sal circulatum*, is reduced into diſſimilar parts, and yields a ſweet oil, very different from the diſtill'd oil; as alſo, that, by the ſame way, there may be ſeparated from wine, a very ſweet and gentle ſpirit, partaking of a far different and nobler quality, than that which is immediately drawn by diſtillation, and call'd dephlegmed *Aqua vitæ*; from whoſe acrimony this other ſpirit is exceedingly remote, altho' the *Sal circulatum*, that makes theſe analyſes, be ſeparated from the analyz'd bodies, in the ſame weight, and with the ſame qualities it had before. This affirmation of *Helmont* if we admit for true, we muſt acknowledge, that there may be a very great diſparity betwixt ſubſtances of the ſame denomination, ſeparable from compound bodies; for beſides the differences I ſhall hereafter take notice of, betwixt thoſe diſtilled oils that are commonly known to chymiſts; it appears from hence, that by means of the *Sal circulatum*, there is quite another ſort of oils, obtainable from the ſame body: and who knows that there are not other agents in nature, by whoſe help there may, whether by tranſmutation, or otherwiſe, be obtained from the bodies vulgarly called mixed, oils, or other ſubſtances, different from thoſe of the ſame denomination, known either to vulgar chymiſts, or even to *Helmont* himſelf?

Secondly, if the opinion of *Leucippus*, *Democritus*, and other ancient and modern philoſophers, be true, that our culinary fire, ſuch as chymiſts uſe, conſiſts of numberleſs little bodies in ſwift motion, which by their ſmallneſs and rapidity are able to permeate the moſt ſolid and compact bodies; it will be reaſonable to ſuppoſe, that multitudes of theſe fiery corpuſcles, getting in at the pores of the containing glaſs, may aſſociate themſelves with the parts of the mix'd body whereon they work, and with them conſtitute new kinds of compounds, according as the ſhape, ſize, and other properties of the parts of the diſſipated body, happen to diſpoſe them, with regard to ſuch combinations. And of theſe, alſo, there may be the greater number, if we grant that ſuch corpuſcles of the fire are not all of the ſame magnitude or figure. And, indeed, ſome particular experiments have induced me to think, that the particles of an open fire, working upon ſome bodies, may really aſſociate themſelves therewith, and add to their quantity*. Tho' I am not ſure, when it operates on bodies included in glaſs veſſels, that the fiery corpuſcles actually paſs thro' the ſubſtance of the glaſs.

But there are ſome bodies, as gold and ſilver, which do not, in the uſual examinations made by fire, diſcover themſelves to be mix'd: and if a re-compound body be ſeparable into ſeveral ſubſtances by the fire, it may be reſolved into ſuch as are neither elementary, nor ſuch as it was upon its laſt mixture compoſed of; but into new kinds of mixtures. Of this I have already produced ſome examples in ſoap, ſugar of lead, and vitriol. Now, if we conſider, that there are ſome bodies, as well natural as factitious, manifeſtly re-compounded; that in the bowels of the earth nature may, as we ſee ſhe ſometimes does, make ſtrange mixtures; that ſome animals are nouriſhed with others, and ſome with plants; and that theſe have their nutriment and growth, either from a certain nitrous juice harbour'd in the pores of the earth; or from the excrements

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* The ſun's rays will inſinuate themſelves into bodies, ſo as greatly to increaſe their weight. M. *Homberg*, by expoſing four ounces of *Regulus Martis* in powder, at the diſtance of about a foot and a half from the focus of the duke of *Orleans*'s large burning-glaſs, found it, after an hour's ſtay there, augmented by about $\frac{1}{10}$ upon the balance; notwithſtanding what was diſſipated in ſmoke. *French Memoirs*, A. 1705. p. 125.

Chymiſtry. of animals; or from the putrefied bodies, either of living creatures, or vegetables; or from other ſubſtances of a compound nature: if, I ſay, we conſider this, it may ſeem probable, that there are among the works of nature, a greater number of re-compound bodies, than men uſually take notice of. And, indeed, as I have formerly, alſo, obſerved, it does not appear, that all mixtures muſt be of elementary bodies; but it ſeems far more probable, that there are ſeveral ſorts of compounds, even in regard of their ingredients, conſider'd antecedently to their mixture. For tho' ſome ſeem to be made up by the immediate coalitions of the elements, or principles themſelves, and may therefore be called *miſta primaria*; yet, it ſeems, that many other bodies are mixed at the ſecond hand; their immediate ingredients not being elementary. And from many of theſe ſecondary ſorts of mix'd bodies, may reſult, by a farther compoſition, a third ſort, and ſo onwards. Nor is it improbable, that ſome bodies are made up of mix'd ones, not all of the ſame order; as for inſtance, a concrete may conſiſt of ingredients, whereof the one may have been a primary, the other a ſecondary mix'd body; (as I have in native cinnabar found a courſer part, that ſeems more properly to be ore, a combuſtible ſulphur, and a running mercury;) or, perhaps, without any ingredient of this latter ſort, it may be compos'd of mix'd bodies, ſome of them of the firſt, and ſome of the third kind. And this may be illuſtrated, by reflecting upon what happens in the chymical preparations, of ſome of thoſe medicines called *Bezoardica*. For firſt, from antimony and iron, which may be look'd upon as *prima miſta*, they compound a ſtarry regulus; to which they put, according to their intention, either gold or ſilver; and this makes with it a new and further compoſition. Then they add ſublimate, which is it ſelf a re-compounded body; and from this ſublimate, and the other metalline mixtures, draw a liquor; which may be allowed to be of a yet more compounded nature; if it be true, as chymiſts affirm, that by this art ſome of the gold or ſilver mix'd with the regulus, may be carried over the helm with it, by the ſublimate; as indeed a skilful and candid perſon complained to me a while ſince, that a friend of his, and mine, having, by ſuch a way, brought over a great deal of gold, in hopes to do ſomething further with it, which might be gainful to him; has not only miſs'd of his aim, but is unable to recover the volatiliz'd gold, out of the antimonial butter wherewith it is ſtrictly united.

Now, if a compound body conſiſt of ingredients not merely elementary; it is eaſy to conceive, that the ſubſtances into which the fire diſſolves it, tho' ſeemingly homogeneous, may be of a compound nature; thoſe parts of each body that are moſt of kin, aſſociating themſelves into a compound of a new kind. Thus when, for example, I have caus'd vitriol, ſal-armoniac, and ſalt-petre, to be mingled and diſtill'd together, the liquor that came over did not manifeſt it ſelf to be either ſpirit of nitre, or of ſal-armoniac, or of vitriol. For none of thoſe would diſſolve crude gold, which yet my liquor would readily do; and thereby ſhewed it ſelf to be a new compound, conſiſting, at leaſt, of ſpirit of nitre, and ſal-armoniac; for the latter diſſolved in the former, will work on gold; which, nevertheleſs, are not by any known way ſeparable; and, conſequently, would not paſs for a mixed body, if we our ſelves did not, to obtain it, put and diſtil together different concretes, whoſe diſtinct operations were known before-hand. And ſuſpecting the common oil of vitriol to be no ſuch ſimple liquor as chymiſts preſume, I mix'd it with an equal, or a double quantity of common oil of turpentine; and having carefully, for the experiment is nice, and ſomewhat dangerous, diſtill'd the mixture in a ſmall glaſs retort, I obtained, according to my deſire, beſides the two liquors I had put in, a conſiderable quantity of a certain ſubſtance, which ſticking all about the neck of the retort, diſcover'd it ſelf to be ſulphur, not only by a very ſtrong ſulphureous ſmell, and by the colour of brimſtone, but alſo by this, that being put upon a coal, it was immediately kindled, and burnt like common ſulphur. So that from this experiment it appears, that a real ſulphur may be made, by the conjunction of two ſuch ſubſtances, as chymiſts take for elementary, and which did neither of them a-part ſeem to contain any ſuch body; or that oil of vitriol, tho' a diſtill'd liquor, and taken for part of the ſaline principle of the concrete that yields it, may contain, beſides its ſaline portion, a ſulphur like common brimſtone, which it ſelf is hardly an uncompounded body.

Fire may compound as well as diſſipate the parts of bodies.

I might here again repeat, that as there may be more elements than five or ſix, ſo the elements of one body may be different from thoſe of another; whence it would follow, that from the reſolution of re-compound bodies, there may reſult mixtures wholly of a new kind, by the coalition of elements, that never, perhaps, convened before. But I proceed to obſerve, that the fire does not always barely reſolve, or take aſunder, but may, alſo, after a new manner, mix and compound together the parts of the body diſſipated by it.

This is ſo obvious, that I cannot but wonder, it ſhould be no more taken notice of. For when wood, by being burnt, is diſſipated into ſmoke and aſhes, that ſmoke compoſes ſoot; which is ſo far from being any one of the principles of the wood, that, as I noted above, you may, by a farther analyſis, ſeparate five or ſix diſtinct ſubſtances from it. And as for the remaining aſhes, the chymiſts themſelves teach us, that by a farther degree of fire, they may be indiſſolubly united into glaſs. 'Tis true, that the analyſis, which the chymiſts principally build upon, is made not in the open air, but in cloſe veſſels; however, the examples lately produced, will lead us to ſuſpect, that heat may as well compound, as diſſipate the parts of mixed bodies. I have known a vitrification made, even in cloſe veſſels. The flowers of antimony, and thoſe of ſulphur, are very mixed bodies, tho' they aſcend in cloſe veſſels; and 'twas in ſtopped glaſſes that I raiſed the whole body of camphire. It may be objected, indeed, that theſe examples are of bodies forc'd up in a dry, not a fluid form, like the liquors obtain'd by diſtillation. But 'tis poſſible a body may be chang'd from ſolid to fluid, or from fluid to ſolid, without being otherwiſe much alter'd; as appears by the readineſs wherewith, in winter, the ſame individual ſubſtance is hardened into brittle ice, and thaw'd again into fluid water. Beſides this, common quick-ſilver it ſelf, which the moſt eminent chymiſts confeſs to be a mix'd body, may be driven over the helm in its priſtine form, and conſequently in that of a liquor. And certainly 'tis poſſible, that very compounded bodies may concur to conſtitute liquors; for I have found it poſſible, by the help of a certain menſtruum, to diſtil gold it ſelf thro' a retort, even with a moderate fire. And butter of antimony, if carefully rectified, may be reduced into a very clear liquor; yet when a quantity of fair water is thrown upon it, there will quickly precipitate a ponderous emetic calx, which before made a conſiderable part of the liquor, and is indeed, an antimonial body, carried over and kept diſſolved by the ſalts of the ſublimate; and conſequently a compounded one, as appears from examining this white powder by a ſkilful reduction. And to ſhew, that bodies, as compounded as the flowers of brimſtone, may concur to conſtitute diſtill'd liquors; which a mix'd body may be brought over the helm without corroſive ſalts; I have ways of bringing over flowers of brimſtone, and perhaps even mineral ſulphurs, wherein I employ none but oleaginous bodies to make volatile liquors; in which not only the colour, but the ſmell, and ſome operations, manifeſt, there is brought over a ſulphur that makes part of the liquor.

And here we ought, again, to remember, that the qualities or accidents, upon account whereof chymiſts call a portion of matter by the name of one of their principles, are not ſuch, but that as great may be produced by the changes of texture, and other alterations, which the fire makes in the ſmall parts of a body. I have already prov'd, by what happens to plants, fed only with fair water, that by changing the diſpoſition of the component parts of a body, nature is able to effect as great changes in a parcel of matter, reputed ſimilar, as thoſe requiſite to denominate one of the *tria prima*. And tho' *Helmont* calls the fire, the artificial death of things; and altho' it has been ſuppoſed, that fire can never generate any thing but fire; yet we ought to conſider, how many new ſorts of mix'd bodies chymiſts themſelves have produced by means of the fire; and particularly that glaſs is not only produced by the manifeſt action of the fire, but has never, for ought we know, been produced any other way. And indeed it ſeems but an inconſiderate aſſertion of ſome *Helmontians*, that every ſort of body, of a peculiar denomination, muſt be produced by ſome ſeminal power. Nor need it much move us, that there are ſome, who look upon whatſoever the fire is employ'd to produce not as natural, but artificial bodies. For there is not always ſuch a difference, as many imagine, betwixt the one and the other; and it is not ſo eaſie as they think, clearly to aſſign what it is, that properly, conſtantly, and ſufficiently diſcriminates them. A thing is commonly term'd artificial, when a parcel of matter is, by the artificer's hand or tools, or both, brought to ſuch a ſhape or form as he deſign'd; whilſt in many of the chymical productions, the effect would be produced, whether the artificer intended it or no; and is often different from what he intended or expected; and the inſtruments employed, are not tools artificially faſhion'd and ſhap'd, like thoſe of tradeſmen, for ſome particular work; but, for the moſt part, agents of nature's own providing; receiving their chief powers of operation from their own nature or texture, not the artificer. The fire is as well a natural agent as ſeed; and the chymiſt, who employs it, only applies natural agents to patients, which, thus brought together, and acting according to their reſpective natures, perform the work themſelves: as fruit is a natural production, tho' the gardener bring and faſten together the ſciens and ſtock, *&c.* But very ſlight qualities may ſerve to denominate a chymical principle. For when they analyze a compound body, by the fire, and obtain a ſubſtance inflammable, that will not mix with water, they preſently call it ſulphur; what comes over ſapid and diſſoluble in water, paſſes for ſalt; and what is fix'd and indiſſoluble in water, that they name earth: and all the volatile ſubſtances they know not what to make of, they call mercury. But that theſe qualities may either be produced otherwiſe than by ſuch as they call ſeminal agents; or may belong to bodies of a compound nature; appears from glaſs made of aſhes, where the ſtrong-taſted alkaline ſalt, joining with the earth, becomes inſipid, and with it conſtitutes a body, which, tho' alſo dry, fix'd, and indiſſoluble in water, is yet manifeſtly a mix'd body, and made ſo by the fire it ſelf. *Helmont* tells us of a way to tranſmute oil of cinnamon, *&c.* wholly into a volatile ſalt, by a bare mixture of its own alkaline ſalt; from whence, if it be true, as I have reaſon to believe, I may argue, that ſince a ſubſtance, that is as well ſaline and volatile as the ſalts of harts-horn, blood, *&c.* which paſs for elementary, is producible by the fire; and ſince this volatile ſalt is really compounded of a chymical oil and a fixed ſalt; the one made volatile by the other, and both aſſociated by the fire; it may well be ſuſpected, that other ſubſtances ariſing from the ſeparation of bodies by the fire, may be new ſorts of mixtures, and conſiſt of ingredients of different natures. Thus, particularly, I have, ſometimes, ſuſpected, that ſince the volatile ſalts of blood, harts-horn, *&c.* are fugitive, and of an exceeding ſtrong ſmell; either the chymiſts erroneouſly aſcribe all odours to ſulphurs, or that ſuch ſalts conſiſt of ſome oily parts well incorporated with the ſaline ones. And the like conjecture I have, alſo, made as to ſpirit of vinegar; which, tho' the chymiſts think one of the principles of that body; and tho' being an acid ſpirit, it ſeems to be much leſs of kin, than volatile ſalts, to ſulphurs; yet not to mention its piercing ſmell, which I know not with what congruity the chymiſts will deduce from ſalt; I wonder they have not taken notice of what their own *Tyrocinium chymicum* teaches, concerning the diſtillation of *Saccharum Saturni*; out of which, *Beguinus* aſſures us, that he diſtill'd, beſides a very fine ſpirit, no leſs than two oils; the one blood-red and ponderous; but the other ſwimming upon the top of the ſpirit, and of a yellow colour. And tho' I remember not, that I have had two diſtinct oils from ſugar of lead; yet that it will, tho' diſtill'd without addition, yield ſome oil, I find by experience. I know the chymiſts will be apt to pretend, that theſe oils are but the volatiliz'd ſulphur of lead, and will, perhaps, argue it from what *Beguinus* relates, that when the diſtillation is ended, you find a *Caput mortuum* extremely black, and good for nothing; as if the body, or at leaſt, the chief part of the metal it ſelf, were, by the diſtillation, carried over the helm. But as *Saccharum Saturni*, is a kind of magiſtery, made only by calcining lead *per ſe*, diſſolving it in diſtill'd vinegar, and cryſtallyzing the ſolution; I found, upon examination, the *Caput mortuum*, ſlighted by *Beguinus*, to be ſo undeſerving the character he gives it, that I venture to ſay, this oil either formerly concurr'd to conſtitute the ſpirit of vinegar, ſo that what paſſes for a chymical principle, may yet be further reſoluble into diſtinct ſubſtances; or that ſome parts of the ſpirit, together with others of the lead, may conſtitute a chymical oil, which, therefore, tho' it paſs for homogeneous, may be a compound body; or at leaſt, that by the action of the diſtill'd vinegar, and the calx of lead, one upon the other, part of the liquor may be tranſmuted from an acid ſpirit into an oil.

Chymiſts muſt, alſo, confeſs, that in the ſpirit of wine perfectly dephlegm'd, or other fermented liquors, that which they call the ſulphur of the concrete, loſes by fermentation, that property of oil, (which the chymiſts likewiſe take to be the true ſulphur of the mixture,) of being immiſcible with water. And if we credit *Helmont*, a pound of the pureſt ſpirit of wine, may barely, by the help of ſalt of tartar, be reſolv'd or tranſmuted into ſcarce half an ounce of ſalt, and as much elementary water, as amounts to the remaining part of the weight. And it may be doubted, whether that fix'd and alkaline ſalt, which is ſo unanimouſly agreed on to be the ſaline principle of incinerated bodies, be not, as 'tis alkaline, a production of the fire. For, tho' the taſt of tartar ſeems to argue, that it contains a ſalt before it be burned; yet that ſalt being very acid, has a quite different taſt from the lixiviate ſalt of calcined tartar. And tho' it be falſly objected againſt the chymiſts, that they obtain all the ſalts they make, by reducing the body they work on into aſhes, with violent fires; yet this volatile ſalt greatly differs from the fix'd alkaline ſalt I ſpeak of, which ſeems not producible by any known way without incineration. 'Tis not unknown to chymiſts, that quick-ſilver may be precipated, without addition, into a dry powder, that remains ſo in water. And ſome eminent men among them teach, that merely by the fire, quick-ſilver may, in convenient veſſels, be reduced into a thin liquor, like water, and miſcible with it. So that by the bare action of the fire, 'tis poſſible, that the parts of a mix'd body, ſhould be ſo diſpos'd, after new and different manners, that it may be ſometimes of one conſiſtence, and ſometimes of another; and in one ſtate be diſpos'd to mix with water, and in another not. I could alſo ſhew, that bodies, from which, a-part, chymiſts cannot obtain any thing combuſtible, may, by being aſſociated together, and by the help of the fire, afford an inflammable ſubſtance; and that, on the other ſide, 'tis poſſible for a body to be inflammable, tho' it would very much puzzle an ordinary chymiſt, to ſeparate an inflammable ingredient from it: wherefore, ſince the principles of chymiſts, may receive their denomination from qualities, which it often exceeds not the power of art, nor always that of the fire, to produce; and ſince ſuch qualities may be found in bodies that differ ſo much in other qualities from one another, that they need not be allow'd to agree in that pure and ſimple nature, which principles ought to have; it may juſtly be ſuſpected, that many productions of the fire, ſhew'd us by chymiſts, as the principles of the concrete that afforded them, may be but a new kind of mix'd bodies. And tho' *Paracelſus*, and ſome of his followers, have ventur'd to teach, that not only the bodies here below, but the elements themſelves, and all the other parts of the univerſe, are compos'd of ſalt, ſulphur, and mercury; yet the learned *Sennertus*, and all the more wary chymiſts, have rejected that conceit; and do, many of them, confeſs, that the *tria prima* are each made up of the four elements; whilſt others of them make earth and water, concur with ſalt, ſulphur and mercury, to the conſtitution of mix'd bodies. So that one ſort of theſe chymiſts, notwithſtanding the ſpecious titles they give to the productions of the fire, do in effect grant what I contend for. And of the other ſort, I demand, to what kind of bodies the phlegm and earth, to be met with in chymical reſolutions, are to be referr'd? For either they muſt ſay, with *Paracelſus*, tho' againſt their own conceſſions, as well as againſt experience, that theſe are alſo compos'd of the *tria prima*, whereof they cannot ſeparate any one from either; or elſe they muſt confeſs, that two of the vaſteſt bodies here below, earth and water, are neither of them compos'd of the *tria prima*; and that conſequently thoſe three are not the univerſal and adequate ingredients of all ſublunary, nor even of all mix'd bodies. The chief of theſe chymiſts, I know, repreſent, that tho' the diſtinct ſubſtances, into which they divide mix'd bodies by the fire, are not pure and homogeneous; yet ſince the four elements, into which the *Ariſtotelians* reſolve the like bodies by the ſame agent, are not ſimple neither; 'tis as allowable for the chymiſts, to call the one principles, as for the *Peripateticks* to call the other elements; ſince in both caſes, the name is grounded only upon the predominancy of them. This argument indeed is of weight againſt the *Ariſtotelians*, but affects not me, who look upon no body as a true principle or element, that is not perfectly homogeneous; but further reſoluble into any number of diſtinct ſubſtances, how ſmall ſoever. And as for the chymiſts calling a body ſalt, ſulphur, or mercury, upon pretence, that the principle of the ſame is predominant in it; this is an acknowledgment, that theſe productions of the fire are yet compounded bodies; tho' whilſt this is granted, it is affirm'd, that the reputed ſalt, ſulphur, or mercury, principally conſiſts of one body, that deſerves the name of a principle. But how do chymiſts make it appear, that there are any ſuch primitive and ſimple bodies as thoſe we are ſpeaking of, ſince 'tis confeſs'd, that theſe are not ſuch? And if they pretend to prove this aſſertion by reaſon, what becomes of their confident boaſts, that they can convince our eyes, by manifeſtly ſhewing, in any mix'd body, thoſe ſimple ſubſtances they pretend them to be compos'd of?

It may, indeed, be plauſibly repreſented in favour of the chymiſts, that, as 'tis evident much the greater part of any thing they call ſalt, ſulphur, or mercury, is really ſuch; it would be very rigid to deny thoſe ſubſtances the names aſcribed them, only becauſe of ſome ſlight mixture of a different body. But ſince 'tis to experience that they appeal, we muſt not take it for granted, that the diſtill'd oil, for inſtance, of a plant, is chiefly compos'd of the pure principle call'd ſulphur, till they have given us an ocular proof, that there is in that ſort of plant ſuch an homogeneous ſulphur. For, as for the ſpecious argument which is drawn from the reſemblance betwixt the productions of the fire, and the reſpective *Ariſtotelian* elements, or chymical principles, by whoſe names they are called; the queſtion is not, whether there be obtained from mixed bodies, certain ſubſtances, that agree in outward appearance, or in ſome qualities, with quick-ſilver, brimſtone, *&c.* but, whether all bodies, confeſs'd to be perfectly mixed, were compoſed of, and are reſoluble into a determinate number of primary, unmix'd bodies. It will not preſently follow, that becauſe a production of the fire has ſome affinity with the greater maſſes of matter here below, therefore they are of the ſame nature, and deſerve the ſame name; for the chymiſts are not content, that flame ſhould be look'd upon as a parcel of the element of fire, tho' it be hot, dry, and active; becauſe it wants ſome other qualities belonging to the nature of elementary fire. Nor will they ſuffer the *Peripatetics* to call aſhes, or quick-lime, earth, notwithſtanding the great likeneſs between them; becauſe they are not taſtleſs, as elementary earth ought to be: but if it be demanded, what it is that all the chymical analyſes of bodies do prove, if they prove not that they conſiſt of the three principles, into which the fire reſolves them? I anſwer, that ſome mixed bodies, included in cloſe veſſels, are reſolvable into ſeveral ſubſtances, different in ſome qualities, but principally in conſiſtence; ſo that out of moſt of them may be obtained a fixed ſubſtance; partly ſaline, and partly inſipid; an unctuous liquor, and another fluid, or more, that, without being unctuous, have a manifeſt taſt. Now, if the chymiſts will agree to call the dry and ſapid ſubſtance, ſalt; the unctuous liquor, ſulphur; and the other, mercury; I ſhall not quarrel with them for it. But if they will tell me, that ſalt, ſulphur, and mercury, are ſimple and primary ſubſtances, whereof each mixed body was actually compounded, and which were really in it antecedent to the operation of the fire; they muſt give me leave to doubt, whether their experiments prove all this. And if they will alſo tell me, the ſubſtances their analyſes afford them, are pure and ſimilar, as principles ought to be; they muſt give me leave to credit my own ſenſes, and their own confeſſions, before their bare aſſertions. But as an element, or principle, ought to be perfectly ſimilar and homogeneous; there is no juſt cauſe why I ſhould rather give a body propoſed, the name of any particular element or principle, becauſe it has a reſemblance to it in ſome obvious quality; rather than deny it that name, upon account of ſeveral other qualities wherein it is unlike.

That the chymical principles are diſſimilar in their nature, ſhewn in ſalts.

The chymiſts will not allow to the *Ariſtotelians*, that the ſalt in aſhes ought to be called earth; tho' the ſaline and terreſtrial parts correſpond in weight, in dryneſs, in fixedneſs, and fuſibility; only becauſe the one is ſapid and diſſoluble in water, and the other not: beſides, we ſee that ſapidneſs and volatility denominate the chymiſts mercury or ſpirit; and yet how many bodies may agree in thoſe qualities, and ſtill have very different natures, and numerous, diſagreeing qualities? For, not only ſpirit of nitre, *Aqua fortis*, ſpirit of ſalt, oil of vitriol, ſpirit of alum, ſpirit of vinegar, and all ſaline liquors, diſtilled from animal bodies; but all the acetous ſpirits of woods, freed from their vinegar, and many others, muſt belong to the chymiſts mercury; tho' it appear not why ſome of them ſhould rather be comprehended under one denomination, than the chymiſts ſulphur or oil; for their diſtilled oils are alſo fluid, volatile, and ſapid, as well as their mercury. Nor is it neceſſary that their ſulphur ſhould be unctuous, or diſſoluble in water; ſince they generally refer ſpirit of wine to ſulphurs; tho' that ſpirit be not unctuous, and will readily mix with water. So that bare inflammability muſt conſtitute the eſſence of the chymiſts ſulphur; as the contrary, joined with any taſt, entitles a diſtill'd liquor to be their mercury. Now, ſince ſpirit of nitre, and ſpirit of hartſhorn, will boil together, hiſs, and throw up one another into the air; which the chymiſts make ſigns of great antipathies in the nature of bodies; ſince I have obtained two ſorts of oil from the ſame parcel of human blood, that would not mix with one another; and ſince I have met with ſeveral examples of the contrariety of bodies, which, according to the chymiſts, muſt be huddled up together under one denomination; I leave it to be conſider'd, whether ſuch a multitude of ſubſtances, as may agree in theſe ſlight qualities, and yet diſagree in others more conſiderable, deſerve to be call'd by the name of a principle; rather than to have ſuch appellations, as may diſtinguiſh them in name, from the bodies they no way reſemble in nature. And hence alſo, by the way, 'tis not unreaſonable to diſtruſt the chymiſts method of arguing; when, being unable to ſhew, that a liquor is, for example, purely ſaline, they prove, that, at leaſt, ſalt is the predominant principle therein; becauſe the propoſed ſubſtance is ſtrongly taſted, and all taſt proceeds from ſalt; whereas thoſe ſpirits, ſuch as that of tartar, of hartſhorn, and the like, which are reckoned to be the mercuries of the bodies that afford them, have maniſeſtly a ſtrong and piercing taſt; as has the ſpirit of box, even after the acid liquor that concurr'd to compoſe it, hath been ſeparated from it. And, indeed, if taſt belong not to the ſpirit, or mercurial principle of vegetables, and animals, I ſcarce know how it will be diſtinguiſh'd from their phlegm; ſince by the abſence of inflammability, it muſt be diſtinguiſh'd from their ſulphur. And here again, we have another example of the inaccuracy of the chymical doctrine; ſince not only the ſpirits of vegetables and animals, but their oils, are very ſtrongly taſted. Nay, a skilful and inquiſitive perſon, who made it his buſineſs, by elaborate operations, to depurate chymical oils, and reduce them to an elementary ſimplicity, informs me, that he never was able to make them taſtleſs; whence I might infer, that the proof which chymiſts confidently give us, of a body's being ſaline, is ſo far from demonſtrating the predominancy, that it does not clearly ſhew ſo much as the preſence of the ſaline principle in it. Again; volatile ſalt of hartſhorn, of amber, of blood, *&c.* are very ſtrongly ſcented; notwithſtanding that moſt chymiſts deduce odours from ſulphur; and from them argue, the predominancy of that principle in the odorous body. Theſe things being thus premis'd, we may the better obſerve, how diſſimilar each of thoſe bodies are, which the chymiſts call the ſalts, the ſulphurs, or the mercuries of the bodies which yield them; as if they had all a natural ſimplicity, and identity of nature; whereas ſalts, for inſtance, if they were all elementary, would differ as little as the drops of pure and ſimple water. 'Tis known, that both chymiſts and phyſicians aſcribe to the fix'd ſalts of calcined bodies, the virtues of their concretes; and, conſequently, very different operations. So we find the alkali of wormwood, much commended in diſtempers of the ſtomach; that of eye-bright, in a weak ſight; and that of guaiacum, in the venereal diſeaſe. And tho' I have long thought, that theſe alkaline ſalts are, for the moſt part, very nearly allied to each other; and retain very little of the properties of the concretes, whence they were ſeparated; yet I have obſerved at the glaſs-houſe, that ſometimes the metal proves of a very different colour, and a ſomewhat different texture; which the moſt ſkilful workmen impute to the aſhes of ſome certain kind of wood; as having obſerved the baſer ſort of glaſs to be frequently produc'd, when they had employed ſuch aſhes; which, therefore, they ſcruple to make uſe of, if they know it. I remember, alſo, that an induſtrious man of my acquaintance, having bought a vaſt quantity of tobacco-ſtalks, to make a fix'd ſalt with, I went to ſee, whether that plant, which ſo much abounds in volatile ſalt, would afford a peculiar kind of alkali; and found, that in the lixivium thereof, it was not neceſſary to evaporate all the liquor as uſual; but the fixed ſalt ſhot into figured cryſtals, almoſt as nitre, or ſal-armoniac, and other uncalcin'd ſalts uſually do. And fixed ſalt of urine, brought by depuration to be very white, I have perceived it taſt not unlike to that of common ſalt, and very different from the general cauſtic, lixiviate taſts of other ſalts, made by incineration. However, I am ſtill inclined to think, that moſt chymiſts, and many phyſicians, inconſiderately, and without warrant from experience, aſcribe the virtues of the concretes, expoſed to calcination, to the ſalts thereby obtained. And, therefore, to ſhew the diſparity of ſalts, I ſhall obſerve the apparent difference betwixt the vegetable fixed ſalts, and the animal, volatile ones; as, for example, betwixt ſalt of tartar, and ſalt of hartſhorn; whereof the former is ſo fixed, that it will endure a violent fire, and ſtand in fuſion, like a metal; whilſt the other will fly away in a gentle heat, as eaſily as ſpirit of wine. And even among the volatile ſalts, there is a conſiderable difference; as appears by the diſtinct properties of ſalt of amber, for inſtance, ſalt of urine, ſalt of man's ſkull, *&c.* And this diverſity of volatile ſalts, is ſometimes diſcernible, even to the eye, in their figure. For the ſalt of hartſhorn will adhere to the receiver, in the form almoſt of a parallelopipid; and of the volatile ſalt of human blood, I have ſeen many grains of a rhomboidal figure; tho' I dare not undertake, that the figures of thoſe, or other ſaline cryſtals, will be always the ſame, whatever degree of fire is employed to force them up; or how haſtily ſoever they have been made to convene in the liquor; in the lower part of which I have uſually obſerv'd them, after a while, to ſhoot. And tho', as I lately ſaid, I ſeldom found any difference, as to medical virtues, in the fixed ſalts of ſeveral vegetables, they having generally agreed, in being diaphoretic and deobſtruent; yet *Helmont* informs us, that there is this difference betwixt the ſaline ſpirit of urine, and that of human blood, that the former will not cure the epilepſy, as the latter will. Of the efficacy alſo, of the ſalt of common amber, againſt the ſame diſeaſe in children, I have ſeen inſtances. And when I conſider, that to obtain theſe volatile ſalts, there is not requiſite ſuch a deſtructive violence of the fire, as to produce thoſe ſalts made by incineration; I am the more ready to conclude, that they may differ from one another, and, conſequently, recede from an elementary ſimplicity. And I have found ſuch various chymical diſtinctions of ſalts, that I cannot but ſay, the chymiſts give themſelves a ſtrange liberty, to call concretes by that name; which, according to their own rules, are to be look'd upon as very compounded bodies; ſo that among thoſe very ſalts which ſeem elementary, becauſe produced upon the analyſis of the bodies that yield them, there is not only a viſible diſparity, but a manifeſt contrariety; as is evident in the ebullition and hiſſing that enſue, when the acid ſpirit of vitriol, for inſtance, is poured upon pot-aſhes, or ſalt of tartar. And not only the ſame body may have two ſalts of a contrary nature, as happens in the ſpirit and alkali of nitre; but from it there may, without addition, be obtained three different, viſible ſalts. For in urine there is a volatile and cryſtalline ſalt, a fixed ſalt, and a kind of ſal-armoniac, or ſuch a ſalt as will ſublime in the form of a ſalt; and therefore is not fixed, tho' far from being ſo fugitive as the volatile ſalt, from which it ſeemed alſo otherwiſe to differ. I have, indeed, ſuſpected, that this may be a proper ſal-armoniac, compounded of the volatile ſalt of urine, and the fixed one of the ſame liquor. And for an ocular proof of the difference betwixt the fixed and volatile ſalt of wood, I deviſed the following experiment. I took a ſtrong ſolution of common *Venetian* ſublimate, made in fair water, and a clear lixivium of wood aſhes; then, on one part of the former ſolution, dropping a little of the latter, the liquors preſently turned of an orange colour; but to another part of the clear ſolution of ſublimate, putting ſome of the volatile ſalt of wood; the liquor immediately turned white, almoſt like milk; and, after a while, let fall a white ſediment, as the other did a yellow one.

In ſulphurs or chymical oils.

This diſparity is, alſo, very remarkable in the ſeparated ſulphurs, or chymical oils of things. For they contain ſo much of the ſcent, taſt, and virtues of the bodies whence they were drawn, that they ſeem to be but the material frame of their concretes. Thus the oils of cinnamon, cloves, *&c.* appear to be but the united aromatic parts of thoſe bodies. And 'tis a known thing, that oil of cinnamon, and oil of cloves, with that of ſeveral woods, will ſink to the bottom of water; whilſt thoſe of nutmegs, and ſeveral other vegetables, ſwim upon it. Oil of roſes ſwims at the top of water, in the form of a white butter; which I remember not to have obſerved in any other oil, drawn in an alembic; yet there is a way by which I have ſeen it ſurprizingly brought over, in the form of other aromatic oils. In oil of aniſeeds, which I drew both with and without fermentation, I obſerved the whole body of the oil, in a cool place, to thicken into the conſiſtence and appearance of white butter; which, with the leaſt heat, reſumed its former liquidity. In the oil of olive, drawn over in a retort, I have, likewiſe, more than once ſeen, a ſpontaneous coagulation in the receiver; and thus congeal'd, it has a ſtrangely penetrating ſcent, as if it would perforate the noſe that approached it.

The like pungent odour I alſo obſerv'd in the diſtill'd liquor of common ſope, which, forced over from *minium*, has afforded an oil moſt admirably piercing. And he muſt be a great ſtranger, both to the writings and preparations of chymiſts, who ſees not in the oils, they diſtil from vegetables and animals, a conſiderable and obvious difference. Nay, from the ſame animal or vegetable, there may often be extracted oils of natures greatly different.

I took a pound of aniſeeds, groſly bruiſed, and caus'd them to be put into a very large glaſs retort, almoſt fill'd with fair water; and placing this retort in a ſand furnace, a very gentle heat was adminiſtred, during the firſt day, and a great part of the ſecond, till the water coming over, had brought with it moſt of the volatile and aromatic oil of the ſeeds; then, increaſing the fire, and changing the receiver, I obtain'd, beſides an empyreumatical ſpirit, a quantity of aduſt oil, whereof a little floated upon the ſpirit; but the reſt was more heavy, and not eaſily ſeparable from it. And tho' theſe oils were very dark, and ſmell'd ſo ſtrongly of the fire, that their odour did not betray from what vegetable they had been forc'd; the other aromatic oil was enrich'd with the genuine ſmell and taſt of the concrete, and ſpontaneouſly coagulated into a white butter. There is another ſort of bodies, which, tho' not obtain'd by diſtillation, many chymiſts call ſulphur; being, for the moſt part, high colour'd, as diſſolv'd ſulphurs uſually are: but eſpecially, becauſe they are generally abſtracted and ſeparated from the reſt of the maſs by ſpirit of wine; which liquor, thoſe men ſuppoſing to be ſulphureous, they conclude, that what it works upon and abſtracts, muſt be a ſulphur alſo. And upon this account, they preſume that they can ſeparate the ſulphur even of minerals and metals; from which, 'tis known, they cannot, by fire alone, obtain it. But if theſe ſequeſtred ſubſtances, were indeed the ſulphurs of the bodies whence they are drawn, there would as well be a great diſparity betwixt chymical ſulphurs, obtain'd by ſpirit of wine, as I have already ſhewn there is betwixt thoſe, obtain'd by diſtillation, in the form of oils; for 'tis plain, that in tinctures, drawn from vegetables, if the ſuperfluous ſpirit of wine be diſtill'd off, it leaves at the bottom the thicker ſubſtance, which chymiſts call the extract of the vegetable. And that theſe extracts are endow'd with very different qualities, according to the nature of the particular bodies that afforded them, is freely confeſs'd both by phyſicians and chymiſts.

And here too, we may take notice, that the chymiſts, in this caſe, as in many others, allow themſelves to abuſe words; for not again to argue from the different properties of tinctures, that they are not exactly pure and elementary ſulphurs; they would eaſily appear not to be ſo much as ſulphurs; altho' we ſhould allow chymical oils to deſerve that name. For, however in ſome mineral tinctures, the natural fixedneſs of the body extracted, does not always ſuffer it, to be, with eaſe, further reſoluble into different ſubſtances; yet in very many extracts;

tracts, drawn from vegetables, it may very eaſily be manifeſted, that the ſpirit of wine has not ſequeſtred the ſulphureous ingredient from the ſaline and mercurial ones; but diſſolv'd the finer parts of the concrete, and united it ſelf with them into a kind of magiſtery; which therefore muſt contain ingredients, or parts of ſeveral ſorts: for we ſee, that the ſtones which are rich in vitriol, being often drench'd with rain water, yield thereto a fine tranſparent ſubſtance, coagulable into vitriol; and yet, tho' this vitriol be readily diſſoluble in water, it is not a true elementary ſalt, but a body reſoluble into very different parts, whereof one is yet of a metalline, and conſequently not of an elementary nature. We may conſider alſo, that common ſulphur is readily diſſoluble in oil of turpentine, tho' it abounds as well in ſalt as in true ſulphur; witneſs the great quantity of ſaline liquor it affords, when ſet to flame away under a glaſs bell. Nay, I have with the ſame oil of turpentine alone, eaſily diſſolv'd crude antimony, finely powder'd, into a blood red balſam, wherewith, perhaps, conſiderable things may be perform'd in ſurgery. And 'tis not unlikely, that ſpirit of wine, which, by its pungent taſt, and ſome other qualities, eſpecially its being reducible, according to *Helmont*, into alkali and water, ſeems to be as well of a ſaline, as of a ſulphureous nature, may well be ſuppos'd capable of diſſolving ſubſtances that are not meerly elementary ſulphurs, tho' perhaps they abound with parts of kin thereto. For I find that ſpirit of wine will diſſolve *Gum. Lacca*, benjamin, and the reſinous parts of jalap, and even of guaiacum; whence we may well ſuſpect, that it may from ſpices, herbs, and other leſs compact vegetables, extract not perfect ſulphurs, but mix'd bodies. And to put this paſt diſpute, there is many a vulgar extract drawn with ſpirit of wine, which committed to diſtillation, will afford ſuch different ſubſtances, as loudly proclaim it to have been a very compounded body. Hence we may juſtly ſuſpect, that even in mineral tinctures, it will not always follow, that becauſe a red ſubſtance may be drawn from a concrete, by ſpirit of wine, that ſubſtance is its true and elementary ſulphur. And tho' ſome of theſe extracts may, perhaps, be inflammable, yet beſides that others are not; and beſides that their being reduced to ſuch minuteneſs of parts, may much facilitate their taking fire; we ſee that common ſulphur, common oil, gum lac, with many unctuous and reſinous bodies, will flame, tho' they be of a very compounded nature: nay, travellers, of unſuſpected credit, aſſure us, as a known thing, that in ſome northern countries, where fir-trees and pines abound, the poorer ſort of inhabitants uſe long ſplinters, of thoſe reſinous woods, to burn, inſtead of candles. And as for the redneſs to be met with in ſuch ſolutions, I could eaſily ſhew, that 'tis not neceſſary it ſhould proceed from the ſulphur of the concrete, diſſolv'd by the ſpirit of wine; by declaring how much chymiſts delude themſelves and others, thro' ignorance of thoſe other cauſes, whereby ſpirit of wine, and other menſtrua, may

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acquire a red or ſome high colour. But to return to our chymical oils; ſuppoſing they were exactly pure, I hope they would only be, as the beſt ſpirit of wine is, the more inflammable and deflagrable. And therefore, ſince an oil may be, by the fire alone, immediately turn'd into flame, I demand how this can be a primogeneal and incorruptible body; as chymiſts would have their principles; ſince it is further reſoluble into flame? Which whether or no it be a portion of the element of fire, as an *Ariſtotelian* would conclude, is certainly ſomething of a very different nature from a chymical oil; ſince it burns, and ſhines, and mounts ſwiftly upwards; which are not the properties of a chymical oil, whilſt it continues in its natural ſtate. If it be objected, that the diſſipated parts of this flaming oil, may be collected again into oil or ſulphur, I ask, what chymiſt has ever done it? And without examining whether it may not hence be as well concluded, that ſulphur is but compacted fire, as that fire is but diffus'd ſulphur; I leave it to be conſidered, whether it may not hence be argued, that neither fire, nor ſulphur, are primitive, undeſtructable bodies; and obſerve, that, at leaſt, it hence appears, that a portion of matter may, without being compounded with new ingredients; by having the texture and motion of its ſmall parts changed, be eaſily, by the means of fire, endow'd with new qualities, more different from what it had before, than are thoſe which ſuffice to diſcriminate the chymiſts principles from one another.

In mercury, or ſpirit.

We are next to conſider, whether in the analyſis of mix'd bodies, that which chymiſts call the mercurial part of them, be uncompounded or no. But tho' chymiſts unanimouſly affirm, that their reſolutions diſcover a principle, which they call mercury; yet I find them to give ſuch different and enigmatical deſcriptions of it, that I know not what to make of them. *Paracelſus*, and many of his followers, call that mercury, which aſcends upon the burning of wood; as the *Peripatetics* take the ſame ſmoke for air; and ſo ſeem to define mercury by volatility. But ſince, in this example, both volatile ſalt and ſulphur make part of the ſmoke, which does, indeed, conſiſt both of phlegmatic and terreſtrial corpuſcles, this notion is not to be admitted. And I find that the more ſober chymiſts themſelves diſavow it. Yet to let us ſee how little clearneſs we are to expect in the chymiſts, *Beguinus*, even in his *Tyrocinium chymicum*, written for the inſtruction of novices, defines mercury thus. "Mercury," ſays he, "is that acid, permeable, penetrable, etherial, and moſt pure ſpirit; from whence proceeds all nutriment, ſenſe, motion, ſtrength, heat, and prolongation of juvenile years." Which words are not ſo much a definition of it, as an encomium; and yet *Quercetan*, in his deſcription of the ſame principle, adds to theſe, ſeveral other epithets. But both of them ſpeak inconſiſtently with the chymical principles. For, if mercury be an acid liquor, either the hermetical philoſophy muſt err in aſcribing all taſts to ſalt; or elſe mercury muſt not be a principle, but compounded.

pounded of a ſaline ingredient, and ſomewhat elſe. *Libavius*, tho' he finds great fault with the obſcurity of what the chymiſts write, concerning their mercurial principle; yet gives us ſuch a negative deſcription of it, as *Sennertus*, how favourable ſoever to the *tria prima*, is not ſatisfied with. And this *Sennertus* himſelf, tho' the learnedſt champion for the hypoſtatical principles, frequently complains of the unſatisfactorineſs of what the chymiſts teach concerning their mercury, ſubſtitutes, inſtead of the deſcription of *Libavius*, another, which many readers know not what to make of.

But ſince the mercurial principle, that ariſes from diſtillation, is unanimouſly aſſerted to be diſtinct from the ſalt and ſulphur of the ſame concrete; perhaps that may be called the mercury of a body, which, tho' it aſcend in diſtillation, as the phlegm and ſulphur, is neither inſipid, like the former, nor inflammable like the latter; and therefore may be term'd ſpirit; which is now very much made uſe of, even by the chymiſts of our times; tho' they have not diſtinctly told us what may properly be call'd the ſpirit of a mix'd body.

However, what the vulgar chymiſts mean by the mercury of animals and vegetables, conſiſtently with their own principles, will not be ſo eaſie to find; for they aſcribe taſts only to the ſaline principle, and conſequently wou'd be much put to it, to ſhew what liquor it is, in the reſolution of bodies, that not being inſipid, is neither inflammable, as oil or ſulphur, nor has any taſt. And if we ſhou'd take ſpirit in the ſenſe of the word receiv'd among modern chymiſts and phyſicians, for any diſtill'd liquor, that is neither phlegm nor oil; the appellation wou'd yet appear ambiguous. For, plainly, that which firſt aſcends in the diſtillation of wine, and fermented liquors, is generally, as well by chymiſts as others, reputed a ſpirit: and yet, pure ſpirit of wine being wholly inflammable, ought, according to them, to be reckon'd the ſulphureous, not the mercurial principle. And among the other liquors, that paſs under the name of ſpirits, there are ſeveral which ſeem to belong to the family of ſalts; ſuch are the ſpirits of nitre, vitriol, ſea-ſalt, *&c.* And even the ſpirit of hartſhorn, being, as I have try'd, in great part, if not totally, reducible into ſalt and phlegm, may be ſuſpected to be but a volatile ſalt, diſguized by the phlegm mix'd with it, in the form of a liquor. But if this be a ſpirit, it manifeſtly differs very much from that of vinegar; the taſt of the one being acid, and the other ſalt; and the mixture of them, in caſe they be very pure, ſometimes occaſioning a ſtrong efferveſcence. And even among ſuch liquors as ſeem to have a better title than thoſe hitherto mentioned, to the name of ſpirits, there appears a ſenſible diverſity: thus ſpirit of oak, for inſtance, differs from that of tartar; and this from that of box, or guaiacum. And, in ſhort, even theſe ſpirits, as well as other diſtill'd liquors, manifeſt a great diſparity betwixt themſelves, either in their actions on our ſenſes, or in their other operations.

And beſides this diſparity, to be met with among thoſe liquors, which the moderns call ſpirits, and take for ſimilar bodies; what I formerly ſaid, concerning the ſpirit of box-wood, may ſhew, that ſome of thoſe liquors, not only have qualities very different from others; but may be further reſolv'd into ſubſtances different from each other.

And ſince many modern chymiſts, and other naturaliſts, take the mercurial ſpirit of bodies for the ſame principle, under different names; I muſt obſerve, that there is a great difference,conſpicuous, betwixt all the vegetable and animal ſpirits I have mention'd, and the pureſt running mercury, ſeparated from metals; which, by ſome chymiſts, that ſeem more philoſophers than the reſt, for diſtinction ſake, call *Mercurius corporum*. Now this metalline liquor being one of thoſe three principles, of which mineral bodies are affirm'd to be compos'd, and to be reſoluble into; the many notorious differences betwixt them and the mercuries, as they call them, of vegetables and animals, will allow me to infer, either that minerals, and the two other ſorts of mix'd bodies, conſiſt not of the ſame elements; or that thoſe principles, whereinto minerals are immediately reſolv'd, which chymiſts, with great oſtentation, ſhew us, as the true principles of them, are but ſecondary principles, or mix'd bodies of a peculiar ſort, which muſt be themſelves reduced to a very different form, to be of the ſame kind with vegetable and animal liquors.

But this is not all; for tho' I formerly ſhew'd how little credit is to be given to the common chymical proceſſes of extracting the mercuries of metals; I will now add, that ſuppoſing the more judicious artiſts truly affirm, they have actually drawn true and running mercury from ſeveral metals; it may be doubted whether ſuch mercuries do not as well differ from common quick-ſilver, and from one another, as from the mercuries of vegetables and animals. *Clavcus* ſpeaking of ſome experiments, whereby metalline mercuries may be fix'd into the nobler metals, * adds, that he means the mercuries drawn from metals; becauſe common quick-ſilver, by reaſon of its exceſſive coldneſs and moiſture, is unfit for that particular kind of operation, wherein, tho' a few lines before he preſcribes, in general, the mercuries of metalline bodies, yet he chiefly commends that drawn, by art, from ſilver. And he, alſo, tells us, he himſelf try'd, that, by bare coction, the quick-ſilver of tin, or pewter, may, by an efficient cauſe, be turned into pure gold †. And the experienc'd *Alexander van Suchten* ſays,

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* According to M. *Homberg*, a perfect metal is nothing but very pure mercury, whoſe ſmall particles are every way pierced and filled with his ſulphureous principle, or the matter of light, which links and binds the whole maſs together. See *French Memoirs*, *A.* 1705. *p.* 122.

† Gold, according to M. *Homberg*, differs from ſilver in nothing but in having the globules of the mercury, whereof it conſiſts, penetrated through and through; and being more fully ſaturated with the ſulphureous principle, or the rays of light, which more plentifully lodge themſelves in

Chymiſtry.

that by a way he intimates, may be made a mercury of copper, not of the ſilver colour of other mercuries, but green. And an eminent perſon lately aſſured me, that he had more than once ſeen the mercury of lead fix'd into perfect gold. And asking him, whether any other mercury wou'd not have been ſo chang'd by the ſame operations, he aſſured me it wou'd not.

The ſulphur of antimony, which is vehemently emetic, and the ſtrongly ſcented anodyne ſulphur of vitriol, incline me to think, that not only mineral ſulphurs differ from vegetable ones, but alſo from one another; retaining much of the nature of their concretes. And *Paracelſus*, in ſome part of his works, declares, that different bodies afford different ſulphurs, ſalts, and mercuries.

And alſo in hlegm and arth.

'Tis alſo obſervable, that thoſe bodies which chymiſts call phlegm and earth, are far from being of an elementary ſimplicity. Thus we ſee, the phlegm of vitriol, for inſtance, is a very effectual remedy againſt burns; and I know a very-famous and experienc'd phyſician, whoſe unſuſpected ſecret it is for diſcuſſing hard and obſtinate tumors. The phlegm of vinegar, tho' drawn exceeding leiſurely in a digeſting furnace, I have purpoſely made tryal of; and, ſometimes, found it able to extract a ſaccharine ſweetneſs out of lead; and, as I remember, by long digeſtion, I diſſolved corals in it. The phlegm of the ſugar of lead is ſaid to have very peculiar properties: many eminent chymiſts teach that it will diſſolve pearls, which being precipitated by the ſpirit of the ſame concrete, are thereby, they ſay, render'd volatile: and this has been confirm'd to me by the obſervation of a perſon of great veracity. The phlegm of wine, and indeed of ſeveral other liquors that are indiſcriminately caſt away as phlegm, have qualities that make them differ, both from meer water, and from each other and tho' the chymiſts call the *Caput mortuum* : of what they have diſtill'd, *terra damnata*; it may be queſtion'd, whether or no thoſe earths are, all of them, perfectly alike; and it is ſcarce to be doubted but that there are ſome of them which remain yet unreduced to no elementary nature. The aſhes of wood, deprived of all the ſalt, and bone-aſhes, or calcin'd harts-horn, which refiners chuſe to make teſts of, as freeſt from ſalt, ſeem unlike; and he who ſhall compare either of theſe inſipid aſhes to lime, and to the calx of talc, will, perhaps, ſee cauſe to think them of a different nature. And it is evident in colcothar, that the exacteſt calcination, follow'd by an exquiſite dulcification, does not alway reduce the remaining body into elementary earth; for after the ſalt or vitriol is drawn out, the remainder appears to be a mix'd body, rich in medical virtues;

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in its pores, than in the pores of ſilver; and from hence he ſuppoſes gold receives its yellow colour, and exceſs of gravity. And proceeding upon this ſuppoſition, he actually produced gold by introducing a large quantity of fire, or the rays of light, into ſilver. See *French Memoirs*, *A.* 1709. *p.* 138—143.

as experience has inform'd me: and *Angelus Sala* affirms it to be partly reducible into malleable copper, which to me ſeems very probable; for having put ſome dulcified colcothar into *Aqua fortis*, I found the liquor, according to my expectation, preſently colour'd as highly as if it had been an ordinary ſolution of copper.

SECT. V.

Whether the five principles ſhou'd be rejected for not being homogeneous?

I Think I have ſufficiently prov'd, that thoſe diſtinct ſubſtances, which chymiſts obtain from mix'd bodies, by their vulgar diſtillation, are not pure and ſimple enough, to deſerve the name of principles, or elements. But I know, there are ſome modern chymiſts, who pretend they can, by further and more ſkilful purifications, ſo reduce the ſeparated ingredients of mix'd bodies to an elementary ſimplicity; that the oils, for inſtance, extracted from all mix'd bodies, ſhall as perfectly reſemble one another as the drops of water.

Now this ſeems to allow what I have been contending for; ſince by pretending to make ſo great a change, in the reputed principles that diſtillation commonly affords, 'tis plainly preſuppos'd, that before ſuch artificial depurations are made, the ſubſtances to be render'd more ſimple, were not ſimple enough before, to be reckon'd elementary; and therefore, if ſome artiſts can perform this, I need not be aſhamed to have queſtion'd the vulgar opinion, as to the *tria prima*. But as to the thing it ſelf, I ſhall not peremptorily deny either its poſſibility, or refuſe my aſſent to any juſt inference, that may be drawn from ſuch performances. But becauſe ſuch promiſes are much more eaſily made, than perform'd, by chymiſts; I muſt with-hold my aſſent to their aſſertions, till their experiments exact it. Beſides, I have not yet found, tho' theſe artiſts pretend to bring the ſeveral ſubſtances, into which the fire has divided the concrete, to an exquiſite ſimplicity, that they pretend alſo, by the fire, to divide all concretes, minerals, and others, into the ſame number of diſtinct ſubſtances. In the mean time, I muſt think it improbable, that they can either truly ſeparate as many different bodies, from gold, for inſtance, or oſteocolla, as we can do from wine or vitriol; or, that the mercury of gold, or lead, would be perfectly of the ſame nature with that of hartſhorn; and that the ſulphur of antimony would be but numerically different from the diſtill'd butter or oil of roſes.

But ſuppoſe we ſhould take earth and water into the number of the principles of mix'd bodies, and changing the ambiguous name of mercury, for that more intelligible one of ſpirit, ſhould, conſequently, make the principles of compound bodies to be five; wou'd it not be too ſevere to reject ſo plauſible an opinion, only becauſe the five ſubſtances, into which the fire divides mix'd bodies, are not exactly pure and homogeneous?

Of this opinion I ſhall only ſay in general, that tho' I think it, in ſome reſpects, more defenſible than that of the vulgar chymiſts; yet it may eaſily appear, that many of the objections, produced againſt the vulgar doctrine of chymiſts, might, without much alteration, be employ'd againſt this alſo. For this doctrine, as well as the other, takes it for granted, that the fire is the true and adequate analyzer of bodies; and that all the diſtinct ſubſtances, obtainable from a mix'd body by the fire, were ſo pre-exiſtent in it, that they were but extricated from each other by the analyſis. This hypotheſis too, aſcribes to the productions of the fire an elementary ſimplicity, which I have ſhewn not to belong to them; and beſides, is liable to ſome of the other difficulties, wherewith that of the *tria prima* is incumber'd. But farther, this number of elements ought, at leaſt, to have been reſtrained to the generality of animal and vegetable bodies; ſince not only among theſe, there are ſome, for ought has hitherto appear'd, that conſiſt either of fewer ſimilar ſubſtances, or more than five. But in the mineral kingdom, there is ſcarce one concrete, that has been ſhewn to be adequately diviſible into five ſuch principles, or elements, neither more nor leſs, as this opinion would have every mix'd body to conſiſt of. And this very thing may ſerve to leſſen our wonder, that juſt ſo many bodies as five, ſhould be found upon the reſolution of concretes. For ſince the fire cannot, as we find, make any ſuch analyſis of metals, and other mineral bodies, whoſe texture is more ſtrong and permanent; it remains, that the five ſubſtances, under conſideration, be obtain'd from ſuch vegetable and animal bodies, as are capable of being diſtill'd. And as to ſuch bodies, 'tis natural enough, that whether we ſuppoſe there are or are not preciſely five elements; there ſhould ordinarily occur five diſtinct ſorts of ſeparated parts. For if the parts do not remain all fix'd, as in gold, calcin'd talc, *&c.* nor all aſcend, as in the ſublimation of brimſtone, camphire, *&c.* but after their diſſipation, aſſociate themſelves into new arrangements of matter; it is very likely, that they will, by the fire, be divided into fix'd and volatile; with regard to that degree of heat by which they are diſtill'd; and thoſe volatile parts will, for the moſt part, aſcend either in a dry form, which chymiſts, if they be taſtleſs, call flowers, and if ſapid, volatile ſalt; or in a liquid form. And this liquor muſt be either inflammable, and ſo paſs for oil, or not inflammable, and yet ſubtil and pungent, which may be call'd ſpirit; or elſe ſtrengthleſs or inſipid, and ſo term'd phlegm or water. And as for the fix'd part, or *Caput mortuum*, it will moſt commonly conſiſt of corpuſcles, partly ſoluble in water, or ſapid, which makes up its fix'd ſalt; and partly inſoluble and inſipid, which, therefore, ſeem to challenge the name of earth. But tho', upon this ſuppoſition, we might eaſily have foretold, that the different ſubſtances, obtain'd from a perfectly mix'd body,

Whence the notion of five chymical principles?

body, by the fire, would generally be reducible to theſe ſtates of matter; yet it will not preſently follow, that theſe five diſtinct ſubſtances were ſimple and primogeneal bodies, ſo pre-exiſtent in the concrete, that the fire does but take them aſunder. Beſides, it does not appear, that all mix'd bodies, nay, nor perhaps all vegetables, are reſoluble by fire, into juſt ſuch different parts of matter. Nor will the experiments formerly alledg'd, permit us to look upon theſe ſeparated ſubſtances, as elementary or uncompounded. It is not a ſufficient argument, of their deſerving the names which chymiſts give them, that they have an analogy in point of conſiſtence, volatility, fixedneſs, or ſome other obvious quality, to the ſuppoſed principles whoſe names they bear. For, as we ſaid above, notwithſtanding this reſemblance in ſome one quality, there may be ſuch a diſparity in others, as ſhould rather give them different appellations, than the reſemblance entitle them to the ſame. And indeed, it ſeems but a groſs way of judging of the nature of bodies, to conclude, without ſcruple, that thoſe muſt be of the ſame nature, that agree in ſome general quality, as fluidity, dryneſs, volatility, and the like; ſince each of thoſe qualities, or ſtates of matter, may comprehend a great variety of bodies, otherwiſe of a very different nature; as we ſee in the calxes of gold, of vitriol, and of *Venetian* talc, compared with common aſhes; which yet are very dry, and fix'd by the vehemence of the fire, as well as they. The ſame alſo appears from what I formerly obſerv'd as to the ſpirit of box-wood; which, tho' a volatile, ſapid, and not inflammable liquor, as well as the ſpirits of hartshorn, of blood, and other things, may yet be ſub-divided into two liquors, different from each other, and one of them, at leaſt, from the generality of other chymical ſpirits.

Whether five be neceſſary in the compoſition of bodies?

'Tis farther urg'd, in behalf of five chymical principles, that ſo many appear abſolutely neceſſary to compound mixed bodies, and to give them a due conſiſtence, and competent duration. For ſalt, ſay the patrons of this opinion, is the baſis of ſolidity and permanency, in compound bodies; without which the other four elements might, indeed, be variouſly and looſely blended together, but would remain incompact; but that ſalt might be diſſolv'd into minute parts, and convey'd to the other ſubſtances to be compacted by it, and with it, there is a neceſſity of water. And that the mixture may not be too hard and brittle, a ſulphureous, or oily principle, muſt intervene, to make the maſs more tenacious: to this a mercurial ſpirit muſt be ſuper-added; which, by its activity, may, for a while, permeate, and, as it were, leaven the whole maſs; and thereby promote the more exquiſite mixture, and incorporation of the ingredients. To all theſe, a portion of earth muſt be join'd; which, by its dryneſs and poroſity, may ſoak up part of that water, wherein the ſalt was diſſolv'd; and eminently concur, with the other ingredients, to give the whole body the requiſite conſiſtence. This opinion I ſhall not now throughly examine; only obſerve, that ſuch a way of arguing may be ſpeciouſly accommodated to different hypotheſes. For I find, that *Beguinus*, and other aſſertors of the *tria prima*, pretend to make out by it, the neceſſity of their ſalt, ſulphur, and mercury, to conſtitute mixed bodies; without requiring any addition of water and earth.

And, indeed, neither ſort of chymiſts ſeem to have duly conſider'd, how great a variety there is in the textures and conſiſtences of compound bodies; and how little the conſiſtence and duration of many of them ſeem to agree with their notions. And, not to mention thoſe almoſt incorruptible ſubſtances obtainable by fire, which I have prov'd to be ſomewhat compounded; and which the chymiſts will readily grant not to be perfectly mixed bodies; I have ſhewn by experiments, that out of common water only, mixed bodies of very different conſiſtences, and reſoluble by fire, into as many principles as other bodies, acknowledged to be perfectly mixed, may be produced. And therefore nature, by a convenient diſpoſition of the minute parts of a portion of matter, may contrive bodies durable enough, and of any conſiſtence, without being obliged to make uſe of all, much leſs of any determinate quantity of each of the five elements, or of the three principles, in their compoſition. And I have wonder'd chymiſts ſhould not conſider, that there is ſcarce any body in nature ſo permanent and indiſſoluble as glaſs; which yet themſelves teach us may be made of bare aſhes, brought to fuſion by the meer violence of the fire. So that, ſince aſhes are granted to conſiſt but of pure ſalt, and ſimple earth, ſequeſtred from all the other principles, or elements; they muſt acknowledge, that even art it ſelf can, of two elements only, or of one principle, and one element, compound a body more durable than almoſt any in the world. How, then, will they prove, that nature cannot compound mixed bodies, and even durable ones, with fewer than all the five elements, or material principles?

Since, then, it may juſtly be doubted, whether the fire be the genuine and univerſal reſolver of mixed bodies; ſince we may doubt, whether all the diſtinct ſubſtances, obtainable from a mixed body by the fire, were pre-exiſtent therein, under thoſe forms wherein they are ſeparated from it; ſince, tho' we grant the ſubſtances, ſeparable from mixed bodies by the fire, to have been their component ingredients, yet the number of ſuch ſubſtances does not appear the ſame in all mixed bodies; ſince, laſtly, thoſe very ſubſtances thus ſeparated, are not generally pure and elementary, but new kinds of mixed bodies; we muſt be allowed to ſay, that the vulgar experiments and arguments, alledged by chymiſts, to prove that their three hypoſtatical principles, adequately compoſe all mixed bodies, will not induce a wary perſon to acquieſce in their doctrine.

And

The imperfections of the chymical doctrine of three principles.

And hence we learn what to judge of thoſe chymiſts, who, becauſe they have found ſeveral compound bodies may be reſolved into, or rather be brought to afford two or three different ſubſtances, more than the ſoot and aſhes, into which the naked fire commonly divides them, cry up their own ſect for the invention of a new philoſophy; ſome ſtyling themſelves philoſophers by the fire; and the major part not only aſcribing, but, as far as in them lies, engroſſing to thoſe of their ſect the title of philoſophers.

But, alas! how narrow is this philoſophy, that reaches but to ſome of thoſe compound bodies, which we find upon the ſurface, or cruſt of our terreſtrial globe; which is it ſelf but a point, in compariſon of the vaſt extended univerſe, of whoſe other and greater parts, the doctrine of the *tria prima* gives us no account? For what does it teach us either of the nature of the ſun, or of that of the fixed ſtars? What does knowing that ſalt, ſulphur, and mercury, are the principles of mixed bodies, inform us of the nature of that vaſt fluid, and etherial ſubſtance, which ſeems to make up the interſtellar part of the world?

We might, however, forgive this hypotheſis, if, tho' it reaches but to a very ſmall part of the world, it gave us a ſatisfactory account of thoſe things, whereto 'tis ſaid to extend. But I find not that it gives any other than a very imperfect information, even about mixed bodies themſelves. For how will the knowledge of the *tria prima*, diſcover the reaſon, why the load-ſtone draws a needle, and diſpoſes it to reſpect the poles, and yet ſeldom to point preciſely to them? How will this hypotheſis teach us, the manner wherein a chick is formed in the egg; or how the ſeminal principles of mint, pompions, and other vegetables, that I formerly mentioned, can faſhion water into various plants, each endowed with its peculiar and determinate ſhape, and with ſeveral ſpecific and diſcriminating qualities? Does this hypotheſis ſhew us, how much ſalt, how much ſulphur, and how much mercury, muſt be taken in, to make a chick, or a pompion? And, if we know this, what principle is it that manages theſe ingredients, and contrives ſuch liquors, for inſtance, as the white and yolk of an egg, into ſuch a variety of textures, as is requiſite to form the bones, veins, arteries, tendons, nerves, feathers, blood, *&c.* of a chick; and not only to faſhion each limb, but to connect them altogether, after a manner ſuitable to the perfection of the animal? For to ſay, that ſome more fine and ſubtile part of the hypoſtatical principles, is the director in this whole affair, and the architect of all this elaborate ſtructure; is to give occaſion to demand again, what proportion, and way of uniting of the *tria prima*, afforded this architectonic ſpirit; and what agent made ſo ſkilful and happy a mixture? I could eaſily proſecute the imperfections of the vulgar chymical philoſophy; and ſhew, that by attempting, from their three principles, to explain even ſuch obvious and familiar phenomena, as fluidity and firmneſs, the

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the colours and figures of ſtones, minerals, and other compound bodies, the nutrition of either plants, or animals, the gravity of gold, or quick-ſilver, compared with wine, or ſpirit of wine, *&c.* from any proportion of the three ſimple ingredients, chymiſts will be much more likely to diſcredit themſelves and their hypotheſis, than to ſatisfie an intelligent enquirer.

This objection, 'tis true, may be made to the four *Peripatetic* elements alſo; and, indeed, almoſt to any other hypotheſis, that pretends, by a determinate number of material ingredients, to ſolve the phenomena of nature. But for the uſe of the *tria prima*, I know their great champion *Sennertus*, aſſigns this noble advantage thereto; that from them, as the neareſt and moſt proper principles, may be demonſtrated the properties of mixed bodies; which cannot be immediately deduced from the elements. And this, ſays he, is chiefly apparent, when we enquire into the properties and faculties of medicines.

And, indeed, if the chymiſts had been ſo modeſt, or ſo diſcreet, as to propoſe their opinion of the *tria prima*, barely as a notion uſeful, among others, to increaſe human knowledge, they had deſerved more thanks, and leſs oppoſition; but ſince the thing they pretend to is not ſo much to contribute a notion towards the improvement of philoſophy, as to make this notion paſs for a new ſyſtem, that will clear and remove all difficulties; 'tis proper they ſhould be made ſenſible of their miſtake, and be adviſ'd to take in more fruitful and comprehenſive principles, if they mean to account for the phenomena of nature.

But when I acknowledge the labours of the chymiſts uſeful to natural philoſophy, I do it upon account of their experiments, not their ſpeculations; for it ſeems to me, that their writings, like their furnaces, afford ſmoke, as well as light; and darken ſome ſubjects, as they illuſtrate others. And tho' 'tis difficult for a man to be an accompliſh'd naturaliſt, who is a ſtranger to chymiſtry; yet I look upon the common operations and practices of chymiſts, as on the letters of the alphabet, without the knowledge whereof 'tis very hard to become a philoſopher; tho' that knowledge is, by no means, ſufficient to make one.

With the advantages thereof, conſider'd.

But to conſider the doctrine of the *tria prima* a little more particularly; I ſhall readily acknowledge it has done the common-wealth of learning ſome ſervice, by helping to deſtroy that exceſſive eſteem, or veneration, wherewith the doctrine of the four elements was generally entertained; tho' what has been alledg'd concerning the uſefulneſs of theſe principles, labours under conſiderable difficulties.

And, firſt, the very way of arguing, uſed by the more learned and ſober champions of the chymical cauſe, to prove the chymical principles in mixed bodies, appears far from convincing. *Sennertus* tells us, that the moſt learned philoſophers thus prove the moſt important points in philoſophy. " Wherever," ſays he," the ſame pro-

“ perties and qualities are found, they muſt neceſſarily exiſt by ſome
“ common principle; thus things are heavy by reaſon of the earth;
“ and hot, by reaſon of the fire they contain; but colours, odours,
“ taſts, inflammability, *&c.* are found in minerals, metals, gems,
“ ſtones, plants, and animals, where they conſequently reſide by ſome
“ common principle: but the elements are not this principle, for
“ they have no power to produce them; we muſt, therefore, enquire
“ for other principles from whence they proceed.”

But this argument is built upon a precarious ſuppoſition, that ſeems to me neither demonſtrable, nor true; for how does it appear, that where the ſame quality is to be met with in bodies, it muſt belong to them upon the account of ſome one body whereof they all partake? For, to begin with that very example he alledges, how can he prove, that the gravity of all bodies proceeds from participating of the element of earth; ſince we ſee, that not only common water, but the moſt pure diſtill'd rain water, is heavy; and quickſilver much heavier than earth it ſelf? And I the rather uſe this example of quick-ſilver, becauſe I ſee not how the aſſertors of the elements, will give any better account of it, than the chymiſts. For if we demand, how it comes to be fluid; they will anſwer, that it greatly participates of the nature of water. And, indeed, according to them, water may be the predominant element in it; ſince we ſee that ſeveral bodies, which by diſtillation afford liquors more, in weight, than their *Caput mortuum*, have not, however, liquor enough to be fluid. Yet if it be demanded, how quick-ſilver comes to be ſo heavy; 'tis reply'd, by reaſon of the earth that abounds in it. But ſince, according to them, it muſt conſiſt of air, and partly of fire, which they affirm to be light elements; how comes it to be ſo much heavier than earth of the ſame bulk; tho', to fill the cavities, it be made into a maſs with water, which, it ſelf, they allow, to be a heavy element? But we ſee, that chymical oils and fixed ſalts, tho' never ſo exquiſitely purified, and freed from terreſtrial parts, remain ponderous. And experience has informed me, that a pound of the heavieſt woods, as guaiacum, that will ſink in water, will yield, when burnt to aſhes, a much leſs weight of them than lighter vegetables; as alſo, that the black charcoal of it will not ſink, as did the wood, but ſwim: which argues, that the different gravity of bodies proceeds chiefly from their particular texture; as is manifeſt in gold, the cloſeſt and moſt compact of bodies; which is many times heavier than we can poſſibly make any parcel of earth of the ſame bulk. I will not examine what may be argued from the gravity of the celeſtial bodies, from the motion of the ſpots in the ſun, and from the apparent equality of the ſuppos'd ſeas in the moon; nor conſider how little thoſe phenomena would agree with what *Sennertus* preſumes concerning it: but to invalidate his ſuppoſition, I demand, upon what chymical principle fluidity depends? And yet fluidity

is, perhaps, two or three excepted, the moſt diffuſed quality of the univerſe; and far more general than almoſt any of thoſe to be met with in the chymical principles, or *Ariſtotelian* elements; ſince not only the air, but that vaſt expanſe we call heaven; and perhaps too the ſun, and fixed ſtars, are fluid bodies. I demand alſo, from which of the chymical principles motion proceeds; which yet is a property of matter much more general than can be deduced from any of the three chymical principles? I might aſk the like queſtion concerning light; which is not only to be found in the kindled ſulphur of mixed bodies, but in living glow-worms, *&c.* and in the vaſt bodies of the ſun and ſtars. I would alſo gladly know, in which of the three principles, the quality we call ſound reſides, as in its proper ſubject; ſince either oil falling upon oil, or ſpirit upon ſpirit, or ſalt upon ſalt, in a great quantity, and from a conſiderable height, will create it; and to make the objection reach the *Ariſtotelians*, water upon water, and earth upon earth. And here let us compare, a little, the ſuppoſition we are examining, with ſome other of their tenets. They teach, in effect, that more than one quality may belong to, and be deduced from one principle: for they aſcribe to ſalt taſts, and the power of coagulation; to ſulphur, odours and inflammability; and ſome of them aſcribe to mercury colours; as all of them do the property of vaniſhing in fume. On the other ſide, it is evident, that volatility belongs, in common, to all the three principles, and to water too. For 'tis manifeſt, that chymical oils are volatile; that alſo ſeveral ſalts, obtained by the analyſis of many concretes, are very volatile, is plain from their aſcending in diſtillation. How eaſily water aſcends in vapours, every body has obſerved; and as for what they call the mercurial principle, this is ſo apt to be raiſed in the form of ſteam, that *Paracelſus* and others define it by that property: hence it ſeems, that chymiſts have been very inaccurate in their doctrine of qualities, and their reſpective principles; ſince they derive ſeveral qualities from the ſame principle, and aſcribe the ſame quality to almoſt all their principles, and other bodies beſides. And hence, alſo, we may learn to judge of the plea, which that fierce champion of the *Ariſtotelians* againſt the chymiſts, *A. Guntherus Billichius* makes, where he pretends to prove, againſt *Beguinus*, that not only the four elements immediately concur to conſtitute every mix'd body, and are both preſent in it, and obtainable from it, upon its diſſolution; but that each of the *tria prima*, manifeſtly conſiſts of all the four: "for," ſays he," 'tis true, in burning green wood we ſee
" water in the ſweat; air in the ſmoke; fire in the flame; and earth in
" the aſhes; but if *Beguinus* will collect the aqueous moiſture, reſtrain the
" oil, and extract the ſalt; I undertake to ſhew him all the four
" elements in each of them, after his own method: thus, for example,
" expoſe the water to the fire, and 'twill exhale in vapour; that is,
" the air; whilſt fire is perceptible in the heat, and earth in the ſediment."

I might

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I might eaſily ſhew how ſuperficially this author talks of dividing the flame of green wood into his four elements, when he makes that vapour to be air, which caught in glaſſes, and condens'd preſently, diſcovers it ſelf to have been but an aggregate of innumerable very minute drops of liquor; and when he wou'd prove the phlegm to be compos'd of fire, by that heat which is adventitious to the liquor, and ceaſes upon the abſence of what produced it. But I rather obſerve, that, taking it for granted fluidity muſt proceed from the element of water, he makes a chymical oil conſiſt of that elementary liquor; and yet in the very next words proves, that it conſiſts alſo of fire, by its inflammability; not remembring that exquiſitely pure ſpirit of wine is both more fluid than water, and yet will wholly flame away, without leaving ſuch matter behind it as he ſuppoſes to be earth. So that the ſame liquor may, according to his doctrine, be concluded, by its great fluidity, to be almoſt all water; and by its burning intirely away, to be all diſguized fire. And, by the like method, our author would ſhew the fixed ſalt of wood to be compounded of the four elements; becauſe being turned, by the violence of the fire, into ſteams, it ſhews it ſelf to be of kin to air; tho' I doubt whether he ever ſaw a true fixed ſalt, brought by the fire alone, to aſcend in the form of exhalations; but if he did, and had caught thoſe exhalations in convenient veſſels, he wou'd have found them, as well as the ſteams of common ſalt, *&c.* of a ſaline, and not of an aerial nature. And tho' he takes it, alſo, for granted, that the fuſibility of ſalt muſt be deduced from water; it is, indeed, ſo much the effect of heat, variouſly agitating the minute parts of a body, without regard to water, that gold will be brought to fuſe by a ſtrong fire; which ſure, is more likely to drive away, than increaſe, its aqueous ingredient, if it had any: and on the other ſide, for want of a ſufficient agitation of its minute parts, ice is ſolid. Thus he preſumes alſo, that the pungent quality of bodies muſt proceed from a fiery ingredient; tho' the light and inflammable parts, which are moſt likely to belong to the element of fire, muſt probably be driven away before the violence of the fire has reduced the body to aſhes: and oil of vitriol, which quenches fire, burns the tongue and fleſh of thoſe who unwarily taſt or apply it. But farther, it is precarious to prove the preſence of fire in fix'd ſalts from their cauſtic power, unleſs it were firſt ſhewn, that all the qualities aſcrib'd to ſalts, muſt be deduced from thoſe of the elements; which is no eaſy task. And not to mention, that our author makes a body as homogeneous, as any he can produce for elementary, belong both to water and fire, tho' it be neither fluid, nor inſipid, like water nor light, and volatile like fire; he ſeems to omit, in this analyſis, the element of earth; only intimates, that the ſalt may paſs for it; tho' a few lines before, he takes aſhes for earth. But ſince there is a manifeſt difference betwixt the ſaline and inſipid parts of aſhes; I ſee not how ſubſtances, that diſagree in ſuch conſiderable qualities, can be both call'd portions of an element, whoſe nature requires it to be homogeneous: the ſaline part of aſhes is very ſtrongly taſted, and eaſily ſoluble in water, whilſt the other part of the ſame is inſipid, and indiſſoluble in that liquor: not to add, that the one ſubſtance is opake, and the other ſomewhat diaphanous; nor that they differ in ſeveral other particulars; ſo that both theſe ſubſtances cannot well be elementary earth. And as to what is ſometimes objected, that the ſaline taſt of aſhes is only an effect of the fire; we before ſhew'd, that tho' inſipid earth may, perhaps, by additions, be turn'd into ſalt; yet 'tis not likely, that it ſhould be ſo by the fire alone. In refining gold and ſilver, the moſt violent fire we can employ, gives them not the leaſt reliſh of ſaltneſs. And refiners, we have ſaid, uſe bone-aſhes for teſts and cupels, which ought to be deſtitute of ſalt, leſt the violence of the fire ſhould bring them to vitrification. And indeed, having purpoſely taſted a cupel, made of only bone-aſhes and fair water, which I had caus'd to be expos'd to a very violent fire, blown with a large pair of double bellows, I could not perceive, that the force of the fire had imparted to it the leaſt ſaltneſs, or ſo much as made it leſs inſipid.

But farther, when our author, tho' a learned man, and one who pretends skill enough in chymiſtry to reform the whole art, comes to give us an ocular demonſtration, as he calls it, of the immediate preſence of the four elements in the reſolution of green wood; he is oblig'd to ſay things inconſiſtent with one another: for, he makes the ſweat, as he terms it, of green wood, to be water; the ſmoke, air; the ſhining matter, fire; and the aſhes, earth; tho' preſently after, he will, in each of theſe, nay, in one diſtinct part of the aſhes, ſhew the four elements. So that either the former analyſis, muſt be inſufficient to prove that number of elements; ſince the burnt concrete is not thereby reduced into elementary bodies, but into ſuch as are yet each of them compounded of the four elements; or elſe theſe qualities, from which he endeavours to deduce the preſence of all the elements in the fix'd ſalt, and each of the other ſeparated ſubſtances, will be but a precarious proof; for the extracted alkali of wood, being, for ought appears, as ſimilar a body as any the *Peripatetics* can ſhew us; if its different qualities muſt argue the preſence of diſtinct elements, it will ſcarce be poſſible for them, by any way of employing the fire upon a body, to ſhew that any ſubſtance is the portion of a true element. This ſhews, that the *Peripatetics*, as well as the chymiſts, take ſome things for granted, which they ought to prove. And when *Sennertus* infers, that becauſe the qualities he mentions, as colours, odours, and the like, belong not to the elements, they therefore muſt to the chymical principles; he takes that for granted, which will not eaſily be prov'd. Thus much may ſuffice, to ſhew the weakneſs of ſuppoſing that almoſt every quality muſt have ſome native receptacle, wherein, as in its proper ſubject of inheſion, it peculiarly reſides; and on whoſe account that quality belongs to the other bodies, wherein it is to be met with. And this fundamental hypotheſis being deſtroyed, whatſoever is built upon it muſt fall.

I further conſider, that chymiſts are far from being able to explain, by any of the *tria prima*, thoſe qualities of matter which they pretend to belong primarily to it, and in mix'd bodies to deduce from it. 'Tis true indeed, ſuch qualities are not explicable by the four elements; but it will not therefore follow, that they are ſo by the three hermetical principles.

I allow then, that the chymiſts do juſtly accuſe the doctrine of the four elements of inſufficiency: but I am miſtaken if our hermetical philoſophers themſelves, need not, as well as the *Peripatetics*, have recourſe to more fruitful and comprehenſive principles than the *tria prima*, to make out the properties of the bodies they converſe with. Thus the vulgar chymiſts aſcribe colours, for inſtance, to mercury; *Paracelſus*, to ſalt; and *Sennertus*, to ſulphur. And *Sennertus*, I fear, wou'd have been exceedingly puzzled to ſolve, by the *tria prima*, half that catalogue of problems, which he challenges the vulgar *Peripatetics* to explain by the four elements. And ſuppoſing it true, that ſalt or ſulphur were the principle to which this or that quality may be peculiarly referr'd; yet this is not enough, in any tolerable meaſure, to ſatisfie an inquiſitive ſearcher after truth. For what is it to know, that ſuch a quality reſides in ſuch a principle or element, whilſt I remain altogether ignorant of the cauſe of that quality, and the manner of its production and operation? How little do I know, more than any ordinary man, of gravity, if I know no more than that the heavineſs of mixed bodies proceeds from that of the earth they are compos'd of; and know not why the earth is heavy? And how little does the chymiſt inſtruct the philoſopher in the nature of purgation, if he only tells him, that the purgative virtue of medicines reſides in their ſalt? Tho' to this it may be objected, that the purging parts of many vegetables, extracted by infuſion, are mix'd with oil, and ſpirit, and earth; and that quick-ſilver precipitated, either with gold or without it, into a powder, is ſtrongly cathartic, notwithſtanding the chymiſts have not proved, that either gold or mercury contain any ſalt at all, much leſs any that is purgative. But even upon their own ſuppoſition, what is it to know that the ſalt of rhubard, for inſtance, purges, if that does not purge as ſalt; for ſcarce any elementary ſalt is, in a ſmall quantity, cathartic; and if we know not how purgation in general is effected in a human body? In a word, as 'tis one thing to know a man's lodging, and another to be acquainted with him; ſo it may be one thing to know a ſubject, wherein a quality reſides, and another to have a right notion of the quality itſelf. Now the reaſon of this deficiency ſeems to be the ſame which renders the *Ariſtotelian*, and ſeveral other theories, inſufficient to explain the origin of qualities. For I am apt to think, men will never be able to account for the phenomena of nature, while they endeavour to deduce them only from the preſence and proportion of particular material ingredients; and conſider them in a ſtate of reſt: moſt of the properties of matter ſeem to depend upon the motion and contrivance of the ſmall parts of bodies. 'Tis by motion, that one part of matter acts upon another; and 'tis, for the moſt part, the texture of the body, upon which the moving parts ſtrike, that modifies the motion or impreſſion, and concurs with it, to produce thoſe effects which come under the conſideration of the naturaliſt.

It will ſtill be urged, that this is an uſeful diſcovery; for, ſince in the ſalt of one concrete, in the ſulphur of another, and in the mercury of another, the medicinal virtue of it reſides; that principle being ſeparated from the reſt, the deſired faculty may be obtained. But ſuch doctrine ſeems uſeful to apothecaries, rather than philoſophers; to make things operate being ſufficient to the former; whilſt the cauſe is the thing look'd after by the latter. Beſides, it will not preſently follow, that becauſe the purgative, or other virtue of the ſimple, may be eaſily extracted by water, or the ſpirit of wine, that it reſides in the ſalt or ſulphur of the concrete; ſince unleſs the body hath before been reſolv'd by the fire, or ſome other powerful agent, it will, for the moſt part, afford in thoſe liquors, rather the finer compound parts of it ſelf, than ſuch as are elementary. Thus water will not only diſſolve pure ſalt, but cryſtals of tartar, gum arabic, myrrh, and other compound bodies; and ſpirit of wine, not only the pure ſulphur of concretes, but likewiſe the whole ſubſtance of ſeveral reſinous bodies, as *Benzoin. Gum. Lacca*, &c. And we ſee, that the extracts, made either with water or ſpirit of wine, are not of a ſimple and elementary nature; but maſſes, conſiſting of the looſer corpuſcles and finer parts of the concretes, whence they are drawn; ſince by diſtillation they may be divided into more elementary ſubſtances.

Again, when there intervenes a chymical reſolution, by the fire, 'tis ſeldom in the more ſaline or ſulphureous principle, that the deſired faculty of the concrete reſides; but that titular ſalt, or ſulphur, is yet a mix'd body, tho' the ſaline or ſulphureous nature be predominant in it. For if the ſubſtances, thus ſeparated, were pure, ſimple, and of a perfect elementary nature, no one wou'd be endowed with more ſpecific virtues than another; and their qualities wou'd differ as little as thoſe of water. And, by the way, even eminent chymiſts have uſed too great diligence in purifying ſome of the things, they obtain by fire, from mix'd bodies. For tho' ſuch compleatly purified ingredients of bodies might, perhaps, be more ſatisfactory to our underſtanding; yet others are often more uſeful to our lives: the efficacy of ſuch chymical productions depending moſt upon what they retain of the bodies, whence they are ſeparated, or gain by the new aſſociations of the disjoined parts; whilſt, if they were merely elementary,

mentary, their uſes would be comparatively very ſmall; and the virtues of ſalts, ſulphurs, or other ſuch ſubſtances of one denomination, wou'd prove the very ſame. For by theſe aſſociations, probably, the number of mixed bodies is conſiderably increaſed; and many of thoſe new productions endowed with uſeful qualities; which they often owe, not to the body from which they were obtained, but barely to this new texture.

But as there are ſeveral concretes, whoſe faculties reſide in one or other of thoſe different ſubſtances, call'd their ſulphurs, ſalts, and mercuries, and conſequently may be beſt obtained by a chymical analyſis; ſo there are others, wherein the nobleſt properties lodge not in the ſalt, ſulphur, or mercury, but depend immediately upon the form, or reſult from the determinate ſtructure of the whole concrete; and, conſequently, thoſe who attempt to extract the virtues of ſuch bodies by the violence of the fire, act ſo as to deſtroy what they would obtain.

Helmont himſelf confeſſes, that as the fire meliorates ſome things, and improves their virtues; ſo it ſpoils others. And other chymiſts have declared themſelves of the ſame opinion.

None of the ſubſtances, into which the fire divides ſalt-petre, retain the taſt, the cooling virtue, or ſome other of the properties of the concrete; whilſt each of thoſe ſubſtances acquires new qualities, not to be found in ſalt-petre it ſelf. The ſhining property of the tail of a glow-worm, ſurvives ſo ſhort a time, the little animal made conſpicuous by it, that inquiſitive men have not ſcrupled publicly to deride *Baptiſta Porta*, and others; who deluded, perhaps, with ſome chymical ſurmizes, have ventured to preſcribe the diſtillation of a water, from the tails of glow-worms, as a ſure way to obtain a liquor ſhining in the dark. And to add another example, amber, whilſt it remains an entire body, has a faculty of drawing to it ſelf feathers, ſtraws, *&c.* which I never could obſerve, either in its ſalt, its ſpirit, its oil, or in the body, I once made by re-uniting its divided elements. And, however boldly chymiſts deduce particular properties, from a determined proportion of their component principles; yet 'tis not always ſo much by virtue of the preſence, or plenty of an ingredient, that the concrete is qualified to produce particular effects, as upon account of the particular texture of that, and the other ingredients, aſſociated after a peculiar manner into one concrete: tho, poſſibly, ſuch a proportion of that ingredient, may be more convenient than another, to conſtitute ſuch a body. Thus in a clock, the hand is mov'd, the bell is ſtruck, and the other actions belonging to the engine perform'd; not becauſe the wheels are of braſs or iron, or part of one metal, and part of another, or becauſe the weights are of lead; but by virtue of the ſize, ſhape, and connection of the ſeveral parts; which would perform the ſame things, tho' the wheels were of ſilver, lead, or wood, and the weight of ſtone; provided the fabric, or contrivance of the engine, were the ſame; tho' braſs and ſteel are more convenient to make clock-wheels of, than lead or wood. Lead, barely by various applications of the fire, will loſe its colour, and acquire ſometimes a grey, ſometimes a yellowiſh, ſometimes a red, and ſometimes an amethyſtine one; and after having paſs'd thro' theſe, and, perhaps, ſeveral others, again recover its own colour, and be made a bright body: and tho' ſo flexible a metal, it may be made as brittle as glaſs; and preſently be brought again to be flexible and malleable as before. Nay, the ſame lead, which thro' a microſcope appears to be one of the moſt opake bodies in the world, may be reduced to a fine tranſparent glaſs; whence yet it may return to an opake nature again; and all this without the addition of any extraneous body; but merely, as we ſaid, by the manner and method of expoſing it to the fire.

Upon the whole, we may very well doubt, whether there be any determinate number of elements, or whether all compound bodies conſiſt of the ſame number of material principles. For it appears from the experiments brought by the common *Peripatetics*, or by the vulgar chymiſts, to demonſtrate that all mixed bodies conſiſt preciſely of the four elements, or the three hypoſtatical principles, are invalid and defective; that the other common arguments, pretended to be drawn from reaſon, in favour of the *Ariſtotelian* hypotheſis, are generally grounded upon ſuch unreaſonable, or precarious ſuppoſitions, that they may as well be rejected as allowed; that if what *Paracelſus* and *Helmont* poſitively deliver of the alkaheſt, be true; it muſt be decided, which of the two reſolvers, that, or the fire, ſhall determine the number of the elements, before we can be certain, how many there are; and that, as the diſtinct ſubſtances, whereinto the alkaheſt divides bodies, are affirmed to be different in nature, from thoſe into which they are reduced by fire, and to be obtained from ſome bodies, more in number, than from ſome others; ſo, altho' we ſhould acquieſce in that reſolution which is made by fire, we find not that all mixed bodies are thereby divided into the ſame number of elements and principles; and, laſtly, that 'tis no more neceſſary to the variety, which ſo greatly conduceth to the perfection of the univerſe, that all bodies ſhould be compounded of the ſame number of elements; than it would be, for a language to have all its words conſiſt of the ſame number of letters.

SECT. VI.

Whether there be any elements at all?

IT may, perhaps, ſeem extravagant to doubt, whether there be a neceſſity to admit any elements, or hypoſtatical principles at all.

But ſuppoſing them to be certain primitive, ſimple, or perfectly unmixed bodies, which not being made of any others, or of one another, are the ingredients whereof all thoſe called perfectly mixed bodies, are immediately compoſed; and into which they are ultimately reſolved; I here propoſe to examine, whether there be any one ſuch body to be conſtantly met with.

The caſe being thus ſtated, I am not reduced to deny, that there are ſuch bodies as earth, and water, quick-ſilver, and ſulphur; but I look upon earth and water as component parts of the terreſtrial globe: and tho' I will not poſitively ſay, there may not, ſometimes, either a running mercury, or a combuſtible ſubſtance, be obtained from a mineral or a metal; yet I need not allow either of them to be an element, in my ſenſe.

In matters of philoſophy, it ſeems a ſufficient reaſon to doubt of an important propoſition, when its truth is not eſtabliſhed by any competent proof. And, therefore, if I ſhew that the grounds upon which men allow of elements, are unſatisfactory to conſiderate perſons, I ſuppoſe my ſcruples will appear rational.

The conſiderations that induce men to think there are elements, may be referr'd to two heads: firſt, that it is neceſſary, nature ſhould make uſe of them, to conſtitute the bodies reputed mix'd. And, ſecondly, that the reſolution of ſuch bodies, manifeſts nature to have compounded them of elementary ones.

That bodies are not compoſed from all the mere elements, ſhewn in the growth of vegetables, and animals.

Now the experiments above produced, concerning the growth of pompions, mint, &c. ſhew, that water may be tranſmuted into all the other elements; from whence we infer, that 'tis not every thing which chymiſts call ſalt, ſulphur, or mercury, that needs always be a primitive and ingenerable body; and that nature may form a plant, without having all the elements previouſly prepared, whereof to compound it. And if we allow the relation formerly mentioned of M. *de Rochas*; not only plants, but animals and minerals too, may be produced out of water. However, there is little doubt, but the plants my own experiments afforded me, would, in caſe I had reduced them to putrefaction, have produced worms, or other inſects, as the reſembling vegetables uſually do; ſo that water may, by various ſeminal principles, be ſucceſſively tranſmuted, both into plants and animals. And if we conſider, that not only men, but ſucking children, are often tormented with ſolid ſtones in the bladder or kidneys; and even beaſts too, tho' they feed but upon vegetables, which, perhaps, are but diſguized water; it will not ſeem improbable, that ſome concretes of a mineral nature may, likewiſe, be form'd of water.

And as a plant may be nouriſhed, and, conſequently, may conſiſt of common water; ſo may both plants and animals be made up of compound bodies, without having any thing merely elementary, afforded them by nature, to be compounded. This is evident in men, who, whilſt they were infants, fed only on milk; and, afterwards, altogether upon fleſh, fiſh, wine, and other perfectly mix'd bodies. It may be ſeen alſo in ſheep, who, on ſome of our *Engliſh* downs, grow very fat, by feeding upon the graſs, without ſcarce drinking at all; and yet more manifeſtly in maggots, that feed and grow up to their full ſize, within the pulp of apples, pears, or the like fruit. We find alſo, that ſuch dungs as abound with a mixed ſalt, haſten the growth of corn, and other vegetables, much more than water alone. And a man experienced in ſuch matters, aſſures me, that, ſometimes, when, to bring up roots very early, the mould they were planted in was made over-rich, the very ſubſtance of the plant has taſted of the dung. And let us conſider a graft of one kind of fruit, upon the upper bough of a tree of another kind; as for inſtance, the ſcion of a pear upon a white-thorn; for there the aſcending liquor is already alter'd, either by the root, or, in its aſcent, by the bark, or both, and becomes a new mix'd body; as may appear by the different qualities, to be met with in the ſaps of ſeveral trees; particularly the medicinal virtue of birch-water, which I have ſometimes drunk, upon *Helmont*'s great and deſerved commendation. Now the graft being faſten'd to the ſtock, muſt neceſſarily nouriſh it ſelf, and produce fruit only out of this compound juice, prepared for it by the ſtock; being unable to come at any other aliment. And conſidering how much of the vegetable fed upon, may remain in an animal; 'tis eaſy to imagine, that the blood of that animal which feeds upon this, tho' a well conſtituted liquor, with all the different corpuſcles that make it up, and kept in order by one preſiding form, may be a ſtrangely compounded body; many of its parts being themſelves compounded. So little neceſſity is there, that even in the mixtures which nature her ſelf makes in animal and vegetable bodies, ſhe ſhould have pure elements at hand to compoſe them of.

As much might, perhaps, be ſaid of minerals, and even metals, if it were as eaſy for us to make experiments, in order to the production of them, as of plants and animals. But the growth or increaſe of minerals, being uſually very ſlow; and, for the moſt part, perform'd in the bowels of the earth, where we cannot ſee it; I muſt, inſtead of experiments on this occaſion, make uſe of obſervations.

And of minerals and metals.

That ſtones were not all made at once, but that ſome of them are ſucceſſively generated, may be fully prov'd by ſeveral examples. There is a famous place in *France*, known by the name of *les Caves Goutieres*, where the water falling from the upper parts of the cave to the ground, preſently condenſes there into little ſtones, of ſuch figures as the falling drops chance to exhibit; ſome of which ſtones have been preſented me. And both *Linſchoten*, and another eminent author, inform us, that, in the diamond-mines in the *Eaſt-Indies*, when having dug the earth, tho' to no great depth, they find diamonds, and take them quite away; yet in a very few years, they find new ones produced in the very ſame place: whence it ſeems probable, that nature does not always require elementary bodies to produce ſtones. And as for metals, authors of good note aſſure us, they have been obſerved to grow; ſo that what was not a mineral or metal before, became one afterwards. Of this it were eaſy to alledge many teſtimonies of profeſs'd chymiſts, and other leſs ſuſpected authors. "Sulphur," ſays *Fallopius*, "preſently grows under ground: there are places where that "mineral having been once dug, and ſuffer'd to reſt for four years, "yield plenty of it again. *Pliny* relates, that iron grows in the "iſland *Ilva* in *Italy*; and *Strabo* expreſsly tells us, that 'tis there dug "up, and continually grows again in the ſpace of an hundred years." *Ceſalpinus* declares, "there is a very plentiful vein of iron in *Italy*;" and that "the iſland *Ilva* is famous for the growth of it; ſo that the "earth caſt up in digging a vein there, will, in tract of time, be "wholly turn'd into a vein again." And *Agricola* owns, that "at a "town call'd *Saga*, in *Germany*, they dig up iron in the fields, by "ſinking ditches two feet deep;" and adds, that "within the ſpace "of ten years, the ditches are dug again for iron newly produced; as "that metal is obtained in *Ilva*." Not to mention what *Galen* notes concerning lead, that it will increaſe both in bulk and weight, if long kept in vaults or cellars; as he gathers from the ſwelling of thoſe pieces of it, which were employed to faſten together the parts of ſtatues; *Boccacius Certaldus* relates, that "there are lead-ſtones in a "mountain near *Florence*; which, if hewn out, will, in a ſhort time, "have their place ſupplied by new ones." *Pliny* alſo mentions, "ſome "lead-mines, where the droſs being thrown in heaps, and ſuffer'd to "lie expoſed to the weather for a few years, yielded a large increaſe "of that metal." 'Tis deliver'd by *Gerhardus*, that "in the valley "of *Joachim*, ſilver is found to grow from the ſtones of the mine, "in the nature of graſs, as from a root, to the length of a man's "finger;" and mentions Dr. *Schreter* as an eye-witneſs; who, alſo, kept by him many pieces of that very metal, ſurprizingly figured.

That induſtrious chymiſt, *Johannes Valchius*, relates, with many concurring ſubſtances, that at a mine, not far from *Strasburg*, call'd *Mariakirch*, a workman accidentally found a large maſs of pure ſilver, weighing 500 pounds, in a hollow place under ground, with no vein, or ore, near it; only ſomething like a burnt matter underneath; from which and other circumſtances, our author concludes, that by the warmth of the place, the noble metalline ſpirits were carried from the neighbouring galleries, or vaults, thro' other ſmaller cracks and clefts, into that cavity; and there collected, as in a cloſe chamber, into one large lump.

And, laſtly, *Agricola* relates, that when he was among the *Hungarian* mines, he obſerved, there would often ariſe in the deep grooves, a warm, innocent ſteam, which faſten'd it ſelf to the ſides; and that coming to review it in two days time, he diſcern'd it all very fix'd and glittering; whereupon having collected it, and diſtill'd it *per retortam*, he thence obtained a fine ſpirit: he adds, that the miners informed him, this ſteam would, at laſt, have become a metal, as gold or ſilver.

Chymiſtry.

From all this, 'tis not very probable, that, whenſoever a mineral, or a metal, is to be generated in the bowels of the earth, nature muſt needs have at hand, ſalt, ſulphur, and mercury, to compound it; for not to urge, that the two laſt relations ſeem leſs to favour the chymiſts, than *Ariſtotle*, who wou'd have metals generated of ſteams; all the obſervations, taken together, make it ſeem more likely, that the mineral earths, or thoſe metalline ſteams, contain ſome ſeminal rudiment, or what is equivalent thereto; by whoſe plaſtic power, the reſt of the matter, tho', perhaps, terreſtrial and heavy, is, in tract of time, faſhion'd into particular metalline ores, almoſt, as we formerly obſerv'd, fair water was, by the ſeminal principle of mint, pompions, and other vegetables, contrived into bodies, anſwerable to their ſeeds. And that ſuch alterations of terreſtrial matter, are not impoſſible, ſeems evident from that notable practice of the ſalt-peter boilers; who unanimouſly obſerve, that if an earth, pregnant with nitre, be depriv'd by the affuſion of water, of all its true and diſſoluble ſalt; yet the ſame earth will, after ſome years, yield them ſalt-peter again. For which reaſon, ſome of the moſt eminent and skilful of them, keep it in heaps, as a perpetual mine of ſalt-peter: whence it may appear, that the ſeminal principle of nitre, latent in the earth, does, by degrees, transform the neighbouring matter into a nitrous body.

A perſon of great credit, and well acquainted with the ways of making vitriol, affirm'd to me, that he had obſerv'd a kind of mineral, which abounds in that ſalt, did, by being kept within doors, and not expos'd to the free air and rains, of it ſelf, in no very long time, turn to vitriol, not only in the outward, or ſuperficial, but even in the moſt central parts.

And, I have alſo met with a certain kind of marcaſite, that lay together in great quantities under ground; which, even in my chamber, began, in a few hours, of it ſelf, to turn into vitriol. Now, as nature, we ſee, makes ſalt-peter out of the earth, that was once almoſt ſcentleſs, and did not find a very fetid, and corroſive acid liquor, and a ſharp alkaline ſalt to compound it of; tho' theſe are the bodies, into which the fire reſolves it; ſo it were not neceſſary, that nature ſhould make up all metals, and other minerals, of pre-exiſtent ſalt, ſulphur, and mercury, tho' ſuch bodies might, by fire, be obtain'd from them. This conſideration, duly weigh'd, is very conſiderable in our preſent enquiry: and hereto agree the relations of our two *German* chymiſts; for it is very improbable, that ſo languid and moderate a heat, as that within the mines, ſhould carry up, to ſo great a height, ſalt, ſulphur, and mercury; ſince we find, in our diſtillations, that it requires a conſiderable degree of fire, to raiſe to the height of one foot, not only ſalt, but even mercury it ſelf, in cloſe veſſels. And if it be objected, that, it ſeems, by the ill ſcent, ſometimes obſerv'd after lightning, that ſulphureous ſteams may aſcend very high, without any extraordinary degree of heat; I anſwer, that the ſulphur of ſilver, is, by chymiſts, ſaid to be a fix'd one.

But the *Ariſtotelians*, and vulgar chymiſts, I preſume, know no better than I, *à priori*, of what ingredients, nature compounds metals and minerals. For their argument, to prove that thoſe bodies conſiſt of ſuch principles, is drawn *à poſteriori*; I mean, their chymical analyſis, which is the ſecond topic from whence they argue.

Now, tho' chymiſts pretend to draw ſalt from ſome minerals, running mercury from others, and from others a ſulphur, yet they have not, hitherto, taught us, by their practice, to ſeparate any one principle from all ſorts of minerals, without exception; and thence, I conclude, none of them to be an ingredient of all bodies.

The ſame ſhewn, alſo, from the analyſis of bodies.

But, ſuppoſing that either ſulphur, or mercury, were obtainable from all ſorts of minerals; ſtill this ſulphur, or mercury, would be a compound, not an elementary, body *. And certainly, he who takes notice of the wonderful operations of quick-ſilver, either the common, or that drawn from mineral bodies, can ſcarce be ſo inconſiderate, as to think it of the very ſame nature, with that immature and fugitive ſubſtance, which chymiſts call the mercury of vegetable and animal ſubſtances. So that when mercury is obtain'd, by the help of the fire, from a metal, or other mineral body; if we are unwilling to ſuppoſe it not pre-exiſtent therein, but produced by the action of the fire, we may, at leaſt, allow this quick-ſilver to have been a perfect body of its own kind, which happen'd to be intimately mingled and coagulated with the other ſubſtances, whereof the metal, or mineral, conſiſted. This may be exemplified by native vermillion; wherein the quick-ſilver, and ſulphur, being exquiſitely blended both with one another, and that courſe mineral ſtuff that harbours them, make up a red body, different enough from both; and yet from hence, part of the quick-ſilver and of the ſulphur, may be eaſily obtain'd. Thus alſo in ſome mines, nature has ſo curiouſly incorporated ſilver with lead, that 'tis extremely difficult, and yet poſſible, to ſeparate the former from the latter. And ſo in native vitriol, the metalline corpuſcles are, by ſkill and induſtry, ſeparable from the ſaline ones; tho' they be ſo coagulated with them, that the whole concrete is reckon'd among ſalts. Now I never could ſee any earth or water, properly ſo call'd, ſeparated from gold or ſilver; and therefore, to retort the argument, I conclude, that ſince there are ſome bodies, in which, for ought appears, there is neither earth nor water; neither of thoſe is an univerſal ingredient of all bodies, counted perfectly mix'd.

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* M. *Homberg* has ſhewn, that all mineral acids will diſſolve quick-ſilver; that ſome of them diſſolve it eaſier than others; that ſome diſſolve it totally, others but in part; leaving a blackiſh ſediment at the bottom, which nevertheleſs is eaſily diſſolved by ſome other acid; that by a particular operation, made to purify mercury exactly, he obtain'd from it a quantity of a light grey powder, of different properties from, but eſſential to it; whence he concludes, that quick-ſilver is not homogeneous in all its parts.] *Memoir. de l'Academ. A.* 1700. *p.* 245.

It may indeed be ſaid, that the reaſon why from gold, or ſilver, we can ſeparate no moiſture, is, becauſe when it is melted out of the ore, the vehement fire, requiſite to its fuſion, forc'd away all the aqueous and fugitive parts. But *Joſephus Acoſta*, relates it, upon his own obſervation, that in *America*, there is a kind of ſilver, whereof the *Indians* ſometimes find pieces, very fine and pure, like ſmall round roots; which, tho' rare in that metal, is uſual in gold: and, beſides this, ſays he, they find ſome, which they call gold in grains; which are ſmall pieces, without mixture of any other metal, and have no need of melting or refining in the fire. And a very ſkilful, and credible perſon, affirm'd to me, that being in the *Hungarian* mines, he had the good fortune to ſee a mineral, that was there dug up, wherein pieces of gold, of the length, and alſo almoſt the bigneſs, of a human finger, grew in the ore, as if they had been parts and branches of trees. And I have my ſelf ſeen, a lump of whitiſh mineral ſtone, that look'd like a kind of ſpar, wherein there grew, here and there, ſeveral little lumps of fine gold, ſome of them about the bigneſs of peaſe.

But *Acoſta* tells us, he has ſeen pieces of pure native gold, that weigh'd ſeveral pounds. And I my ſelf, have ſeen a piece of ore, lately dug up, in whoſe ſtony part there grew, almoſt like trees, ſeveral parcels of a metal, which ſeem'd to be very pure, or unmix'd with any heterogeneous ſubſtances; and were ſome of them as big as my finger.

To proceed to the conſideration of the analyſis of vegetables. My trials indeed, give me no cauſe to doubt, that five different ſubſtances, may, generally, be obtain'd from them by the fire; yet, I think, it will not be eaſily demonſtrated, that theſe deſerve to be call'd elements, in the ſenſe above deliver'd.

And before I deſcend to particulars, I muſt premiſe this general conſideration, that theſe different ſubſtances called elements, or principles, differ not from each other, as plants, animals, and metals; or as creatures, immediately produced, each by its peculiar ſeed, and conſtituting a diſtinct propagable ſort of creatures in the univerſe; for theſe are only various ſchemes of matter, that differ from each other, but in conſiſtence, and ſome very few other accidents, as taſt, ſmell, inflammability, or the want of them; ſo that by a change of texture, not impoſſible to be wrought by the fire and other agents, that have the faculty to diſſociate the ſmall parts of bodies, and afterwards to connect them after a new manner, the ſame parcel of matter may acquire or loſe ſuch accidents as ſuffice to denominate it ſalt, ſulphur, or earth; whence the fire may as well produce ſome new textures, in a parcel of matter, as deſtroy the old.

If

The tria prima *ſeem to be productions of the fire.*

If we doubt not the truth of ſome of *Helmont*'s relations, we may well queſtion, whether any of theſe heterogeneous ſubſtances exiſt in the concrete, whence they are obtain'd by the chymical analyſis. For, not to inſiſt upon the uninflammable ſpirit of ſuch concretes; becauſe that may be pretended to be but a mixture of phlegm and ſalt; the oil or ſulphur of vegetables or animals is, according to him, reducible, by the help of lixiviate ſalts, into ſope; as that ſope is, by repeated diſtillations, from a *Caput mortuum* of chalk, into inſipid water. And as for the ſaline ſubſtance, that ſeems to be ſeparable from mixed bodies; the ſame *Helmont*'s tryals give us cauſe to think it may be a production of the fire, which, by tranſpoſing and otherwiſe altering the particles of the matter, brings it to a ſaline nature. "For I "know," ſays he, "a way to reduce all ſtones into a meer ſalt, "of equal weight with that from whence it was produced, without "the leaſt mixture of either ſulphur or mercury." Which aſſeveration wou'd, perhaps, ſeem leſs incredible, if I durſt here ſay all I cou'd upon that ſubject. And hence, by the way, we may, alſo, conclude, that the titular ſulphur and mercury, obtained by analyſis, from compound bodies, may, poſſibly, in many caſes, be the productions of fire; ſince, if the ſame bodies had been wrought upon by *Helmont*'s agents, they would have yielded neither ſulphur nor mercury; and thoſe portions of them, which the fire wou'd have preſented in the form of ſulphureous and mercurial bodies, might, by his method, have been exhibited in the form of ſalt.

Phlegm not an univerſal and pre-exiſtent ingredient of mixed bodies.

But it is not ſo eaſy to reject water and earth, eſpecially the former, as 'tis to reject the *tria prima*, from among the elements of mix'd bodies: however, every difficult thing is not impoſſible. As to water, the chief qualities which occaſion men to give that name to any viſible ſubſtance, are, that it is fluid, inſipid, and inodorous: but I have never ſeen any of thoſe ſeparated ſubſtances chymiſts call phlegm, which was perfectly deſtitute both of taſt and ſmell. And if it be ſaid, that ſince the whole body is liquid, the maſs is nothing but elementary water, faintly imbued with ſome of the ſaline or ſulphureous parts of the ſame concrete, which it retain'd upon its ſeparation from the other ingredients; I anſwer, that this objection wou'd not appear ſo ſtrong as plauſible, if chymiſts underſtood the nature of fluidity and compactneſs. I formerly obſerved that, to make a body fluid, there is nothing neceſſary but that it be divided into parts ſmall enough; and that theſe parts be put into ſuch a motion amongſt themſelves, as to glide ſome one way and ſome another, along each others ſurfaces; ſo that altho' a concrete were never ſo dry, or had not any water, or other liquid exiſtent in it; yet ſuch a comminution of its parts may be made by the fire, or other agents, as to turn a great portion of them into liquor. For if ſea-ſalt be melted in the fire, to free it from the aqueous parts, and afterwards diſtill'd with a vehement heat, from burnt clay, or any other very dry *Caput mortu-*

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num, a large portion of the ſalt will be driven over in the form of a liquor. And to ſhew, that a great part of this liquor was ſtill true ſea-ſalt, brought by the operation of the fire into corpuſcles ſo ſmall, and, perhaps, ſo advantagiouſly ſhap'd, as to be capable of the form of a fluid body; I poured to ſuch ſpirituous ſalts a due proportion of the ſpirit of urine, and thereby, having evaporated the ſuperfluous moiſture, ſoon obtain'd ſuch another concrete, both as to taſt, ſmell, and eaſy volatility, as common ſal-armoniac. And further, to manifeſt that the corpuſcles of the ſea-ſalt, and the ſaline ones of urine, retain their ſeveral natures in this concrete, I mixed it with a convenient quantity of ſalt of tartar, and committing it to diſtillation, ſoon regained the ſpirit of urine, in a liquid form by its ſelf; the ſea-ſalt remaining behind with the ſalt of tartar. It is, therefore, very poſſible, that dry bodies may, by the fire, be reduced to liquors, without any ſeparation of elements; but barely by a certain kind of diſſipation and comminution of the matter, whereby its parts are brought into a new ſtate. If it be ſtill objected, that the phlegm of mix'd bodies muſt be reputed water, becauſe ſo weak a taſt needs but a very ſmall proportion of ſalt to impart it; I reply, that for ought appears, common ſalt, and ſeveral other bodies, tho' diſtill'd whenever ſo dry, and in veſſels ever ſo cloſe, will yield, each of them, a conſiderable quantity of a liquor, wherein, tho' as I lately noted, ſaline corpuſcles abound, yet there is beſides, a large proportion of phlegm; as may be eaſily diſcovered by coagulating the ſaline corpuſcles with any convenient body; as we coagulated part of the ſpirit of ſalt with ſpirit of urine. And I have often ſeparated a ſalt from oil of vitriol it ſelf, by boiling it with a juſt quantity of mercury, and then waſhing the newly coagulated ſalt from the precipitate, with fair water. Now to what can we more probably aſcribe this plenty of an aqueous ſubſtance, afforded by the diſtillation of ſuch bodies, than to this, that among the various operations of the fire upon the matter of a concrete, ſeveral particles of that matter are reduced to a ſhape and ſize requiſite to compoſe ſuch a liquor, as the chymiſts call phlegm, or water? 'Tis proper here to reflect upon what we formerly ſaid, concerning the change of quick-ſilver into water; for the water having but a very faint taſt, if at all more than many of thoſe liquors which chymiſts refer to phlegm; it ſeems evident from ſuch an experiment, that even a metalline body, and, therefore, much rather a vegetable or animal one, may, by a ſimple operation of the fire, be turn'd, in great part, into water. And ſince the chymiſts are not yet able out of gold, ſilver, *&c.* to ſeparate any thing like water; I may be allow'd to conclude againſt them, that water is not an univerſal and pre-exiſtent ingredient of mix'd bodies.

But ſuppoſing the truth of what *Helmont* relates of the alkaheſt's effects; it may be alledg'd, that he could tranſmute all reputed mix'd bodies into mere inſipid water. But tho' his affirmations conclude ſtrongly againſt the vulgar chymiſts, ſince they prove, that the common principles, or ingredients of things, are not permanent and indeſtructible, becauſe they may be further reduced into inſipid phlegm, different from them all; yet, till we can be allow'd to examine this liquor, it is not unreaſonable to doubt, whether it be not ſomething elſe than meer water. For, I find no other reaſon, why *Helmont* pronounces it ſo, but becauſe it is inſipid. Now ſapor, being a property of matter, that relates to our organs of taſt; it may very poſſibly happen, that the ſmall parts of a body ſhall be of ſuch a ſize and ſhape, as either by their extreme minuteneſs, by their ſlenderneſs, or by their figure, to be unable to pierce into, and make perceptible impreſſions upon the nerves, or membranous parts of the tongue or palat; and yet be fit to work otherwiſe upon ſeveral bodies, than meer water, and, conſequently, to ſhew it ſelf to be of a nature far from elementary. In dyed ſilk, whilſt many contiguous threads make up a skein, the colour is conſpicuous; but if only a very few of them be view'd, the colour will appear much fainter than before; and if only a ſingle thread, 'tis not eaſie to diſcern any colour at all; ſo ſubtile an object wanting the force to make an impreſſion upon the optic nerve, great enough to be taken notice of. It is alſo obſerv'd, that the beſt ſort of oil-olive is almoſt taſtleſs, tho' it be vaſtly remote in nature, from water. The liquor, into which mercury may be tranſmuted, has, ſometimes, but a very languid taſt; yet its operations, even upon ſome mineral bodies, are very peculiar. Quick-ſilver it ſelf, alſo, tho' the corpuſcles it conſiſt of are ſo very ſmall, as to get into the pores of gold, is altogether taſtleſs. And *Helmont* ſeveral times tells us, that fair water, wherein a little quantity of quick-ſilver has lain for ſome time, tho' it acquire no certain taſt, or other ſenſible quality, has a power to deſtroy worms in a human body. And a great lady, eminent for her beauty in ſeveral courts, confeſs'd to me, that this inſipid liquor was, of all innocent waſhes for the face, the beſt ſhe ever met with.

Beſides, it deſerves to be remark'd, that, as we are accuſtomed to drink nothing but wine, beer, or other ſtrongly taſted liquors, there may be in ſeveral of thoſe that paſs for inſipid phlegm, very peculiar and diſtinct taſts, tho' unheeded by us. For, to omit what naturaliſts affirm of apes, that they have a more exquiſite palat than us; among men themſelves, thoſe who drink nothing but water, may, as I have try'd in my ſelf, diſcern a great difference of taſt in ſeveral waters; which one unaccuſtomed to drink water, wou'd take to be all alike inſipid. And 'tis not impoſſible, that the corpuſcles, into which a body is diſperſed by the fire, may thereby have their figures ſo altered, or, by aſſociations with one another, be brought into little maſſes, of ſuch a ſize and ſhape, as to be unfit to make ſenſible impreſſions on the tongue. The ſharpeſt ſpirit of vinegar having diſſolv'd as much coral as it can, will coagulate with it, into a ſubſtance, which, tho' ſoluble in water, like ſalt, is incomparably leſs ſtrongly taſted than the vinegar was before. And tho' the acid ſalts carried up with quick-ſilver in the preparation of common ſublimate, are ſo ſharp, that, moiſtened with water, they will corrode metals; yet this corroſive ſublimate, being twice or thrice re-ſublim'd with a full proportion of inſipid quick-ſilver, conſtitutes *Mercurius dulcis*; ſo call'd, becauſe the ſharpneſs of the corroſive ſalts is ſo taken away, by their combination with the mercurial corpuſcles, that the whole mixture, when prepared, is judged inſipid.

Nor earth. For ſuch reaſons I cannot admit elementary water as a conſtant ingredient of mix'd bodies. And as for earth, it may well be ſuſpected, that many ſubſtances paſs, among chymiſts, under the name of it; only becauſe, like that, they are dry, heavy, and fix'd; tho' yet very far from an elementary nature. This ſeems probable from what I formerly ſaid of that the chymiſts call the *terra damnata* of things, and particularly concerning the copper to be drawn from the *Caput mortuum* of vitriol; to which we may add a remarkable experiment made by *Johannes Agricola* upon the *terra damnata* of brimſtone. This author tells us, that having prepared an oil of ſulphur, he reverberated the remaining feces, in a moderate fire, for fourteen days; and afterwards put them, well luted up, in a wind-furnace, with a ſtrong fire, for ſix hours; propoſing to calcine them to perfect whiteneſs. But coming to break the pot, he found very little feces on the top, and thoſe grey; whilſt beneath there lay a fine red regulus, which, at firſt, he knew not what to make of; being well aſſured, that not the leaſt thing beſides the feces of the ſulphur came into the pot; and that the ſulphur itſelf had only been diſſolved in linſeed oil. This regulus he found heavy and malleable, almoſt as lead. Having caus'd a goldſmith to draw him a wire of it, he found it to be of the fineſt copper, and ſo rightly colour'd, that a Jew of *Prague* offer'd him a great price for it. And of this metal, he ſays, he had ſix ounces from one pound of feces. Hence we may well ſuſpect, that ſince the *Caput mortuum* of the ſulphur remain'd ſo long in the fire, before it was found to be any thing elſe than a *terra damnata*; there may be other reſidences of bodies, which paſs only for the terreſtrial feces of things, and are therefore thrown away as ſoon as the diſtillation or calcination is ended, which yet, if long and skilfully examined by the fire, would appear to be different from elementary earth. And I have taken notice of the unwarrantable forwardneſs of common chymiſts, to pronounce things uſeleſs feces, by obſerving how often they reject the *Caput mortuum* of verdigreaſe; which is ſo far from deſerving to be call'd ſo, that not only by ſtrong fires and convenient additions, it may, in ſome hours time, be reduced to copper; but with a certain flux-powder, I have, in two or three minutes, obtain'd that metal from it. And having kept *Venetian* talc, in the heat of a glaſs-furnace, I found, after all the violence of the fire it had endured, the remaining body, tho' brittle and diſcolour'd, had not loſt very much of its former bulk; and ſeemed ſtill to be nearer allied to talc, than to meer earth. And I remember too, that a candid mineraliſt, famous for his skill in trying ores, importuning me to procure him a certain *American* mineral earth; I enquired of him, why he ſeemed ſo deſirous of it; when he confeſs'd, that it having been brought to the public ſay-maſters, and they being unable by any means to bring it to fuſion, or make it fly away, he had procured a little of it; and having try'd it with a peculiar flux, he ſeparated from it near a third part of pure gold: ſo great miſtakes may be committed in haſtily concluding things to be uſeleſs earth!

Next, 'tis poſſible, that as in the reſolution of bodies by the fire, ſome of the diſſipated parts may, by their various occurſions, be brought to ſtick ſo cloſely together, as to conſtitute corpuſcles, too heavy for the fire to carry away; ſo, other agents may reſolve the concrete into minute parts, after ſuch a different manner, as not to produce any *Caput mortuum*, or dry and heavy body. Thus *Helmont* informs us, as we before obſerved, that with his great diſſolvent, he divided a coal into two liquid and volatile bodies, equal in weight to the coal, without any dry or fixed reſidence at all. And, indeed, it ſeems not neceſſary, that all agents, which reſolve bodies into portions of differently qualified matter, ſhould work on them in the ſame way, and divide them into juſt ſuch parts, both for nature and number, as the fire ſeparates them into. For ſince, as I lately noted, the bulk and ſhape of the ſmall parts of bodies, together with their fitneſs and unfitneſs, to be eaſily put into motion, may render the ſubſtances they compoſe, as different from each other, as ſome of the chymical principles; why may not ſomething happen in this caſe, like what is uſual in the groſſer diviſions of bodies by mechanical inſtruments? Thus ſome tools reduce wood, for inſtance, into parts of ſeveral ſhapes, bigneſs, and other qualities; as hatchets and wedges divide it into groſſer portions, ſome more long and ſlender, and others more thick and irregular, all of conſiderable bulk; but raſps and ſaws make a comminution of it into duſt; whilſt others divide it into long, broad, thin, flexible parts, as planes. And of this kind of parts, it ſelf, there is alſo a variety, according to the difference of the tools employed; the ſhavings made by the plane, being in ſome things different from thoſe ſhives obtained by the borer.

In a mixture of ſulphur, and ſalt of tartar, well melted and incorporated together, the action of pure ſpirit of wine digeſted on it, is to ſeparate the ſulphureous from the alkaline parts, by diſſolving the former, and leaving the latter; whilſt the action of wine upon the ſame mixture, is to divide it into corpuſcles, conſiſting of both alkaline and ſulphureous parts united. 'Tis true, this is but a factitious concrete; however, the inſtance may ſerve to illuſtrate what I propos'd, if not to prove it: and nature her ſelf, in the bowels of the earth, makes compounded bodies, as we ſee in vitriol, cinnabar, and even in ſulphur it ſelf. Beſides, fire divides new milk into five different ſubſtances; tho' runnet, and acid liquors, ſeparate it but into a coagulated matter, and a thin whey; and, on the other hand, churning divides it into butter, and butter-milk; which may, either of them, yet be reduced to other ſubſtances, different from the former. And whereas ſpirit of wine will diſſociate the parts of camphire, and make them one liquor with it ſelf; *Aqua fortis* will alſo disjoin them, and put them into motion, but ſo as to keep them together, and yet alter their texture into the form of an oil. I know, alſo, an uncompounded liquor, that an extraordinary chymiſt would not allow to be ſo much as ſaline; which from coral it ſelf, not only obtains a noble tincture, without the aſſiſtance of nitre, or other ſalts; but will carry it over in diſtillation. And I make a menſtruum, that more odly aſſociates the parts of minerals very fix'd in the fire. Whence it ſeems not incredible, that there may be ſome agent, or way of operation found, whereby ſome concretes, if not all firm bodies, are reſoluble into parts ſo very minute, and ſo apt to adhere cloſely to one another, that none of them may be fix'd enough to ſtay behind in a ſtrong fire; and, conſequently, are not to be look'd upon as earth. *Helmont*, alſo, affirms, that he can reduce all the terreſtrial parts of mix'd bodies into inſipid water; whence we may argue againſt the earth's being an element. And ſince a body, from which the fire hath driven its looſer parts, is ſuppoſed to be earth, for being inſipid and fix'd; if natural agents can deprive the *Caput mortuum* of a body, of either of thoſe two qualities; or give them both to a portion of matter that had them not before; the chymiſts will not eaſily ſhew, what part of a reſolv'd concrete is earth, or that earth is a primary, ſimple, and indeſtructible body. Now, there are ſome caſes, wherein the more skilful of the vulgar chymiſts themſelves, pretend to be able, by repeated cohobations, and other operations, to make the diſtilled parts of a concrete bring its own *Caput mortuum* over the helm, in the form of a liquor; in which ſtate, being both fluid and volatile, it cannot well be taken for earth. And, indeed, by a skilful, but not vulgar way of managing ſome concretes, there may be more effected in this kind, than one would eaſily imagine. And, on the other hand, that either earth may be generated, or, at leaſt, that bodies, which did not before appear to be totally earth, may be ſo alter'd as to paſs for it, ſeems very poſſible, if *Helmont* hath done that by art, which he mentions in ſeveral places; eſpecially where he ſays, that he knows ways whereby ſulphur once diſſolv'd, may, all of it, be fix'd into a terreſtrial powder; and the whole body of ſalt-petre turn'd into earth.

And theſe things ſeem the leſs impoſſible, from what we have deliver'd as to the growth of vegetables, nouriſhed by water alone. And *Rondeletius* tells us of a fiſh he kept in a glaſs of water, without any other food for three years; in which ſpace it conſtantly augmented; till at length it could not come out of the orifice at which it was put in; and, at laſt, grew too big for the glaſs it ſelf. Now there is no juſt reaſon to doubt, that this fiſh, if diſtill'd, would have yielded the like different ſubſtances with other animals; and becauſe the mint which I produced out of water, afforded me, upon diſtillation, a large quantity of charcoal; I think I may from hence infer, that earth it ſelf may be produced out of water; or that water may be tranſmuted into earth; and, conſequently, tho' earth could be proved an ingredient actually exiſtent in the vegetable and animal bodies, whence it may be obtained by fire; it would not neceſſarily follow, that earth, as a pre-exiſtent element, concurs with other principles to make up thoſe bodies, whence it ſeems to have been ſeparated.

It will, perhaps, be retorted upon me, that there may be elementary bodies; ſince I allow gold for an ingredient, in a multitude of different mixtures; which ſtill retains its nature, notwithſtanding all that the chymiſts, by their fires and corroſive waters, can do to deſtroy it.

Gold it ſelf, deſtructible; and new qualities producible in bodies, by a bare change of texture.

But I propoſed this example, chiefly to ſhew how nature may be conceived to have made elements; not to prove that ſhe actually has made any; and *à poſſe ad eſſe*, is no juſt inference. But to anſwer the objection more directly; I muſt own, that tho' many of the more ſober chymiſts have complained of the vulgar ones, as of cheats, for pretending to deſtroy gold; yet I know a certain menſtruum of ſo piercing and powerful a quality, that if, notwithſtanding much care and ſome skill, I did not greatly deceive my ſelf, I have with it, really deſtroyed even refined gold; and brought it into a metalline body, of a different colour and nature; as I found by trials purpoſely made. And I have learnt from experience, that a menſtruum may be made to ſeparate and retain ſeveral parts from bodies, which even the more judicious and experienced chymiſts have pronounced irreſoluble by the fire; tho' in neither of theſe inſtances could the gold, or precious ſtones, be analyz'd into any of the *tria prima*; but only reduced to new concretes. And, indeed, there is a great diſparity betwixt the operations of the ſeveral agents, whereby the parts of a body come to be ſeparated. Thus, for inſtance, if you diſſolve the purer ſort of vitriol in common water, the fluid will ſwallow up the mineral, and ſo diſſociate its corpuſcles, that they will ſeem to make but one liquor with thoſe of the water; and yet each of theſe corpuſcles retains its nature and texture, and remains a vitriolate and compound body. But if the ſame vitriol be expoſed to a ſtrong fire, it will then be divided, not only, as before, into ſmaller parts, but into heterogeneous ſubſtances; each of the vitriolic corpuſcles that remained entire in the water, being it ſelf, upon the deſtruction of its former texture, divided into new particles of different qualities. And tho' there were ſaline, ſulphureous, or terreſtrial portions of matter, with parts ſo ſmall, ſo firmly united together, or of a figure ſo fit to make them cohere to one another, that neither the fire, nor the uſual agents employed by chymiſts, are piercing enough to divide their parts, ſo as to deſtroy the texture of the ſingle corpuſcles; yet it would not neceſſarily follow, that ſuch permanent bodies muſt be elementary; ſince 'tis poſſible there may be agents found in nature, ſome of whoſe parts are of ſuch a ſize and figure, as to take better hold of theſe ſeemingly elementary corpuſcles, than they do of the reſt; and, conſequently, may carry away ſuch parts with them, and ſo diſſolve the texture of the corpuſcle, by pulling its parts aſunder. And if it be ſaid, that, at leaſt, we may this way diſcover the elementary ingredients of things, by obſerving into what ſubſtances theſe corpuſcles, that were reputed pure, are divided; I anſwer, 'tis not neceſſary ſuch a diſcovery ſhould be practicable. For if the particles of the diſſolvent, take ſuch firm hold of thoſe of the diſſolv'd ſubſtance, they muſt, together, conſtitute new bodies, as well as deſtroy the old. And the ſtrict union which, according to this hypotheſis, may well be ſuppoſed betwixt the parts of the produced body, will make it as improbable they ſhould be ſever'd but by particles of matter, that, to divide them, aſſociate, and ſtick extremely cloſe to ſuch as they ſeparate from their former adherents. Beſides, it is not impoſſible, that a corpuſcle, ſuppoſed to be elementary, may have its nature changed, without ſuffering a divorce of its parts, barely by a new texture, effected by ſome powerful agent; as I formerly ſaid, the ſame portion of matter may, eaſily, by the operation of the fire, be turned into the form of a brittle and tranſparent, or an opake and malleable body.

And, indeed, if we conſider how far the bare change of texture, whether made by art or nature, can go, in producing ſuch new qualities, in the ſame parcel of matter; and how many inanimate bodies we know to be denominated, and diſtinguiſhed, not ſo much by any imaginary ſubſtantial form, as by the aggregate of theſe qualities; and that the variation of figure, ſize, motion, ſituation, or connexion of the corpuſcles, whereof any of theſe bodies is compoſed, may alter the fabric of it; we ſhall have cauſe to ſuſpect, that there is no need that nature ſhould always have elements provided, whereof to compoſe mix'd bodies; and that it is not ſo eaſy as chymiſts and others have hitherto imagined, to diſcern, which among the many different ſubſtances, without any extraordinary skill, to be obtained from the ſame portion of matter, ought, excluſive of the reſt, to be eſteem'd its elementary ingredients; much leſs to determine what primogeneal and ſimple bodies conſpir'd together to compoſe it.

I formerly intimated, that beſides mint and pompions, I produced ſeveral other vegetables, of very different natures, out of water; and therefore, 'tis not abſurd to ſuppoſe, that when a ſlender vine-ſlip, is ſet in the ground, and takes root there, it may, likewiſe, receive its nutriment from the water, attracted out of the earth by its roots, or impell'd by the warmth of the ſun, or preſſure of the ambient air, into the pores of them. This ſeems the more probable, from obſerving what a ſtrange quantity of water will drop out of the wound, given to the vine, in a convenient place, at a ſeaſonable time, in the ſpring; and how little of taſt, or ſmell, this liquor is endow'd with, notwithſtanding what concoction, or alteration, it may receive in its paſſage thro' the vine, to diſcriminate it from common water. Suppoſing then, this liquor, at its firſt entrance into the roots of the vine, to be common water; let us a little conſider, how many various ſubſtances may be obtain'd from it. And firſt, being digeſted in the plant, and aſſimilated by the ſeveral parts thereof, it is turn'd into wood, bark, leaves, *&c.* 'tis further modify'd and faſhion'd into vine-buds; and theſe ſoon after, advance to ſour grapes; which expreſs'd, yield verjuice; a fluid, very different, in ſeveral qualities, both from wine and other liquors, obtainable from the vine. Theſe ſour grapes being, by the heat of the ſun, concocted and ripen'd, turn to well-taſted grapes; which, if dry'd in the ſun and diſtill'd, afford a fetid oil, and an empyreumatical ſpirit, but not a vinous one; theſe dry'd grapes, or raiſins, boil'd in a convenient proportion of water, make a ſweet liquor; which, by diſtillation, affords an oil and ſpirit, much like thoſe of the raiſins themſelves: if the juice of the grapes be ſqueez'd out, and put to ferment, it firſt becomes a ſweet, turbid liquor; then grows leſs ſweet, and more clear; next affords, in common diſtillations, not an oil, but a ſpirit; which, tho' inflammable, like oil, differs greatly from it. I have likewiſe, without addition, obtain'd, in proceſs of time, from one of the nobleſt ſorts of wine, a large quantity of pure, and curiouſly figur'd cryſtals of ſalt, together with a great proportion of a liquor, almoſt as ſweet as hony: and theſe I obtain'd, not from muſt, but true and ſprightly wine. Beſides the vinous liquor, the fermented juice of grapes, is partly turn'd into liquid dregs, or lees, and partly into that cruſt, or dry feculency, that is commonly call'd tartar; and this tartar may, by the fire, be eaſily divided into five different ſubſtances; four of which are not acid, and the other not ſo manifeſtly acid as the tartar it ſelf. The ſame vinous juice, after ſome time, degenerates into that very ſour liquor, call'd vinegar; from which you may obtain, by the fire, a ſpirit, and a cryſtalline ſalt, different enough from the ſpirit, and lixiviate ſalt of tartar. And if you pour the dephlegm'd ſpirit of the vinegar upon the ſalt of tartar, there will be produced a violent conflict or ebullition; and often in this vinegar, you may obſerve, part of the matter to be turn'd into innumerable ſwimming animals, clearly diſcernible without the help of a microſcope.

Into all theſe various ſchemes of matter, or differently qualified bodies, beſides ſeveral others, that I purpoſely forbear to mention, may the water, imbibed by the roots of the vine, be reduc'd, partly by the formative power of the plant, and partly by ſupervenient agents or cauſes, without the viſible concurrence of any extraneous ingredient: but if we are allow'd to add to the productions of this tranſmuted water, a few other ſubſtances; we may much increaſe the variety of ſuch bodies: altho', in this ſecond ſort of productions, the vinous parts ſeem ſcarce to retain any thing of the much more fix'd bodies, wherewith they were mingled; but only to have, by their mixture with them, acquired ſuch a diſpoſition, that in their receſs, occaſion'd by the fire, they came to be alter'd, as to ſhape or magnitude, or both, and aſſociated after a new manner. Thus, as I formerly ſaid, by the addition of a *Caput mortuum* of antimony, and ſome other bodies, unfit for diſtillation, I obtain'd from crude tartar, plenty of a very volatile and cryſtalline ſalt, greatly different in ſmell, and other qualities, from the uſual ſalts of tartar.

I am, however, very far from thinking, that this ſalt is what *Paracelſus* and *Helmont* mean, when they ſpeak of *Sal tartari volatilis*; and aſcribe ſuch great things to it. For, my ſalt falls extremely ſhort of thoſe virtues; not ſeeming, in its taſt, ſmell, or other obvious qualities, to differ very much from ſalt of hartſhorn, and other volatile ſalts, drawn from the diſtill'd parts of animals. Nor have I yet made trials enow, to be ſure that it is a pure ſalt of tartar, without participating of the nitrous antimony. But, becauſe it ſeems more likely to proceed from the tartar, than from any of the other ingredients, and becauſe the experiment is in it ſelf not contemptible, nor unſuitable to the preſent occaſion, I ſhall ſet down the method I uſe to make it.

A volatile ſalt of tartar, how prepared.

Take of good antimony, ſalt-petre, and tartar, of each an equal weight, and of quick-lime, half the ſame weight; let theſe be powder'd, and well mix'd; this done, have in readineſs a retort of earth, which muſt be placed in a furnace, for a naked fire, with a hole at the top, at which you may caſt in the mixture, and preſently ſtop it up again: this veſſel, being fitted with a large receiver, muſt have a fire made under it, till the bottom and ſides be red hot; and then, you muſt throw in the mixture, by about half a ſpoonful at a time; and nimbly ſtopping the hole, the fumes will paſs into the receiver, and there become a liquor, that being rectified, will appear of a pure golden colour. This ſpirit abounds in the ſalt; part of which may eaſily be ſeparated, by putting the liquor into a bolthead, with a long narrow neck; for being plac'd, a little inclining, in hot ſand, there will ſublime up a fine ſalt, which, as I ſaid, I find to be much of kin to the volatile ſalts of animals; ſince, like them, it has a ſaltiſh, not an acid taſt; hiſſes upon the affuſion of ſpirit of nitre, or oil of vitriol; precipitates coral diſſolv'd in ſpirit of vinegar; turns ſyrup of violets immediately green; preſently changes the ſolution of ſublimate into a milky whiteneſs; and has ſeveral operations, like thoſe I have obſerv'd in the ſort of ſalts whereto I reſemble it; and is ſo volatile, that, for diſtinction's ſake, I call it *Sal tartari fugitivus*. What virtues it may have in phyſic, I have not yet had the opportunity to try; but I am apt to think they will not

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not be deſpicable. A friend of mine tells me, he has done great matters in the ſtone, with a preparation, not very different from ours; and a very experienced *German* chymiſt aſſured me, that in a great city of his country, one has procured a privilege, that none but he, or by his licence, ſhould ſell a ſpirit, made almoſt after the ſame way with mine; only he leaves out the quick-lime. 'Tis alſo a common cuſtom in *France*, to bury thin plates of copper in the husks of grapes, whence the juice has been ſqueez'd in the wine-preſs; and by this means, the more ſaline parts of thoſe husks, gradually working upon the copper, coagulate themſelves with it, into that bluiſh green ſubſtance we call verdigreaſe; of which I therefore take notice, becauſe having diſtill'd it in a naked fire, I found, that by the aſſociation of the ſaline with the metalline parts, the former were ſo alter'd, that the diſtill'd liquor, even without rectification, ſeem'd, by ſmell and taſt, ſtrong, almoſt like *Aqua fortis*; and very much ſurpaſs'd the pureſt, and moſt rectified ſpirit of vinegar that ever I made. And this ſpirit I aſcribe to the ſalt of the husks, alter'd by their mixture with the copper; becauſe I found the latter, at the bottom of the retort, in form of a crocus, or reddiſh powder; and becauſe copper is of too ſluggiſh a nature to be forced over, in cloſe veſſels, by no ſtronger a heat. And 'tis, to me, remarkable, in the diſtillation of good verdigreaſe, that it never yielded me any oil, tho' both tartar and vinegar will, by diſtillation, afford a moderate proportion thereof. If, likewiſe, you pour ſpirit of vinegar upon calcined lead; the acid ſalt of the liquor will, by mixing with the metalline parts, tho' inſipid, acquire, in a few hours time, a more than saccharine ſweetneſs; and theſe ſaline parts being, by a ſtrong fire, diſtill'd from the lead, wherewith they were incorporated, will, as I formerly noted, leave the metal behind them, alter'd in ſome qualities; whilſt themſelves aſcend partly in the form of an unctuous body, partly in that of phlegm, but, for the greateſt part, in the form of a ſubtile ſpirit, of a ſtrong ſcent, very different from that of vinegar, and of a piercing taſt, remote both from the ſourneſs of the ſpirit of vinegar, and the ſweetneſs of the ſugar of lead.

In ſhort, as the difference of bodies may depend meerly upon that of the arrangement of their common matter; ſo, the ſeeds of things, the fire, and other agents, are able to alter the minute parts of body; and the ſame agents, partly by altering the ſhape and magnitude of the conſtituent corpuſcles, partly by driving away ſome of them, and partly by a new manner of connecting them, and others with them, may give the whole portion of matter a new texture of its minute parts, and thereby make it deſerve a new and diſtinct name. So that according as the ſmall parts of matter recede from, or work upon each other, or are connected together after ſome determinate manner, a body of a particular denomination is produced, when another happens thereby to be alter'd or deſtroy'd.

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Since, then, thoſe things which chymiſts produce by the help of the fire, are but inanimate bodies; ſince ſuch fruits of their ſkill differ from one another, but in ſo few qualities, that by fire and other agents which we can employ, we may eaſily work as great alterations upon matter, as thoſe required to change one of theſe chymical productions into another; ſince the ſame portion of matter may, without being compounded with any extraneous body, or, at leaſt, any element, put on ſuch a variety of forms, and conſequently be ſucceſſively turn'd into ſo many different bodies; and laſtly, ſince the matter, cloath'd with ſo many different forms, was, originally, only water, that, in its paſſage, thro' ſo many transformations, was never reduced into any of thoſe ſubſtances, which are reputed the principles, or elements, of mix'd bodies; except by the violence of the fire, which it ſelf divides not bodies, into perfectly ſimple and elementary ſubſtances, but into new compounds; I ſee not why we muſt needs believe, that there are any primogeneal and ſimple bodies, of which, as of pre-exiſtent elements, nature is oblig'd to compound all others. And why may ſhe not produce the bodies accounted mix'd, out of one another, by variouſly altering and contriving their minute parts; without reſolving the matter into ſuch ſimple and homogeneous ſubſtances as are pretended? Neither does it ſeem abſurd to think, that, when a body is reſolv'd, by the fire, into its ſuppos'd ſimple ingredients, thoſe ſubſtances are not true and proper elements, but rather, accidental productions of the fire; which, by ſeparating a body into minute parts, does, if thoſe parts be ſhut up in cloſe veſſels, for the moſt part, neceſſarily bring them to aſſociate after another manner than before; and ſo reduce them into bodies of thoſe different conſiſtences, that the former texture, and concurrent circumſtances, render ſuch disjoin'd particles apt to conſtitute. Thus experience ſhews us, that as there are ſome concretes, whoſe parts, when ſeparated by fire, are fitted to be put into ſuch ſchemes of matter as we call oil, ſalt, and ſpirit; ſo there are others, particularly the greateſt part of minerals, whoſe corpuſcles, being of another ſize or figure, or, perhaps, contriv'd in a different manner, will not, in the fire, yield bodies of the like conſiſtences, but rather of different textures.

To ſum up the evidence on both ſides. Firſt, we have ſeen, that the different ſubſtances, into which mix'd bodies have been commonly reſolv'd, by the fire, are not of a pure, and elementary nature; but retain ſo much of the concrete that afforded them, as to appear to be yet compounded; and often to differ in one concrete, from principles of the ſame denomination in another: ſecondly, that as to the number of theſe different ſubſtances, it is not preciſely three; becauſe, in moſt vegetable, and animal bodies, earth and phlegm, are alſo to be found among their ingredients; and that there is not any one determinate number, into which the fire, as it is uſually em-

employ'd, preciſely and univerſally reſolves all compound bodies whatſoever, as well mineral as others, that are reputed perfectly mix'd: and laſtly, that there are ſeveral qualities which cannot be referr'd to any of theſe ſubſtances, as if they primarily reſided therein, and belong'd thereto; and that ſome other qualities, which, tho' they ſeem to have their chief, and moſt ordinary reſidence in one or other of theſe principles, or elements, of mix'd bodies, are not yet ſo deducible from thence, but that more general principles muſt be taken in to explain them.

On the other hand, it appears, firſt, that ſeveral mineral bodies may be reſolv'd into a ſaline, a ſulphureous, and a mercurial part; and that, almoſt, all vegetable, and animal concretes, may, by a skilful artiſt, be divided, by the fire, into five different ſubſtances, ſalt, ſpirit, oil, phlegm, and earth; of which, the three former, being much more operative than the two latter, may be look'd upon as the three active principles; and, by way of eminence, be call'd the three principles of mix'd bodies: ſecondly, that theſe principles, tho' they be not perfectly ſimple, may, without inconvenience, be ſtiled the elements of compound bodies, and bear the names of thoſe ſubſtances which they moſt reſemble, and which are manifeſtly predominant in them; becauſe no one of theſe elements ſeems diviſible, by the fire, into four or five different ſubſtances, like the concrete whence it was ſeparated: laſtly, that ſeveral qualities of a mix'd body, and eſpecially the medicinal virtues, do, for the moſt part, lodge in one or other of its principles, and may, therefore, uſefully be ſought for in that principle ſever'd from the others.

Upon the whole, as I could make many plauſible exceptions to ſome of the arguments I have here employ'd; ſo, perhaps, ſeveral of them will not readily be anſwer'd, by the chymiſts, till they alter, or reform, their hypotheſis. And, therefore, if either of the two opinions, I have examin'd, or any other theory of elements, ſhall, upon rational, and experimental grounds, be clearly made out; I am not ſo far in love with ſcepticiſm, as not to leave it to embrace the truth, when it appears: but, in this caſe, I muſt ſay, that the inquiries of others have ſcarce been more unſatisfactory to me than my own.

SECT. VII.

That chymical principles are tranſmutable.

I Formerly queſtion'd, whether the fire be the true and proper inſtrument of analyzing mix'd bodies, and do but diſſociate their principles or ingredients, without altering them, or compounding them a-new. But I ſhall now ſhew, that the vulgar opinion of chymiſts,

miſts, as to this matter, ought to be rejected. The occaſion of making the following experiments was this. An ingenious chymiſt told me, that by endeavouring to purify an eſſential oil by rectification, he found, to his diſappointment, that tho' he diſtill'd it four or five times ſucceſſively, yet it ſtill left ſome feces; tho' he concluded, that if he ſhould undergo the trouble of diſtilling the liquor a few times more, it would come over perfectly pure, without leaving any feculency behind it. But 'twas more agreeable to my hypotheſis, that the *Caput mortuum* he complained of, was not a groſs or feculent part of the oil, ſeparated from the more pure; but a new compound produced, as other concretes alſo might be, by the operation of the fire. This conjecture is favoured by ſome experiments, I made many years before, whereby two diſtill'd liquors, barely from their mutual reactions, afforded a great quantity of an earthy and very fixed ſubſtance. And it ſeem'd agreeable to the ſame conjecture, that by obſtinately repeating the experiment, the action of the fire upon the parts of the body, expoſed to it, and their mutual operations and combinations among themſelves, and, probably, too, the material concurrence of igneous particles, might produce, beſides earthy feces, other bodies not unlike thoſe that paſs for the chymiſts principles. How far the event proved agreeable to his hypotheſis, will be beſt gather'd from the phenomena themſelves, of the tryals whereof I ſhall here give an account. But firſt I muſt premiſe, that by an eſſential oil, chymiſts mean ſuch a fine oleagenous liquor, as, to prevent an empyreuma and feculent parts, has been diſtill'd with plenty of water in a limbec.

Shewn from the phenomena afforded by an eſſential oil, in repeated diſtillations.

Now, we took a pound of pure eſſential oil of aniſeeds, and having put it into a glaſs-retort of a convenient ſize, we cauſed it to be diſtill'd, (in a ſand-furnace, capable of giving a ſtrong fire) thirty ſix times, in which train of operations, the enſuing phenomena offer'd themſelves.

As pure as the eſſential, or the etherial oils of vegetables are preſum'd to be, and as confidently as chymiſts pretend they are the pure ſulphurs, or unctuous principles, of the bodies that afford them; yet, not only the firſt diſtillation left a ſubſtance black, like pitch, at the bottom of the retort; but, at every one of the following diſtillations, ſuch a ſubſtance was either ſeparated or generated.

Tho' after a diſtillation or two, it ſeemed likely, that this pitchy ſubſtance would be every time leſs and leſs; yet I not only found, that at each diſtillation ſuch a black-ſubſtance was left; but that, now and then, a ſubſequent diſtillation yeilded much more of it than the precedent; which change, from leſs to more, and from more to leſs, was ſeveral times obſerved. And tho' this odd pitchy ſubſtance were, towards the latter end, found in leſs quantity, than at the beginning; yet the cauſe may well be, that the oil to be diſtill'd did ſenſibly, from time to time, decreaſe in bulk, by reaſon of the receſs of that portion of the oil, which could not but be diſſipated and loſt in ſo many cohobations; and chiefly, by the loſs of ſo much oil as was tranſmuted into pitch and other ſubſtances.

The oil appeared, in diſtillation, more fixed or unapt to riſe than one would have expected from ſo fine and light a liquor; and eſpecially towards the latter end of the diſtillations, it was often neceſſary to employ a ſcarce credible degree of fire, to elevate all that was not turned into pitch.

The liquor did not diſtil like a pure principle or homogeneous body, as quick-ſilver does; but firſt ſome fine and light oil uſually came over, after which followed a leſs volatile oil, with another ſubſtance or two, and after that, another aſcended in a diſtinct manner.

For 'tis to be noted, that beſides the fore-mentioned black earth, there were produced, by the operation of the fire, ſeveral other ſubſtances, whereof the firſt was a wateriſh liquor or phlegm; which, after the oil had been expoſed to ſome diſtillations, began to grow very troubleſome. For being rarified by the heat of the fire into large bubbles, the incongruity between them and the oil, occaſioned a kind of conflict, wherein theſe bubbles often ſuddenly broke, with great noiſe, and ſometimes with ſuch violence, as to ſhake and endanger the retort; which once, by this conteſt, was actually broken; yet not ſo, but that the liquors and other products of the fire were ſaved, and ſeaſonably transferred into a new retort.

Beſides this phlegm and the pitch, our operation afforded us, from time to time, a large quantity of a certain ſubſtance, which, with ſome, paſſed for a volatile ſalt; becauſe it aſcended to the upper part of the veſſel, and appeared in a dry form, almoſt like ſhort needles; and becauſe, alſo, it ſeemed, that, like a ſalt, it was diſſoluble in the ſpirituous phlegm. But tho' at firſt, I inclined to this opinion; yet having made ſome few tryals to examine the truth of it, I ſtill am a little doubtful, whether this ſublim'd body deſerve the name of a true volatile ſalt; tho' poſſibly there may be much of that contain'd in it. For I found the lumps of it, notwithſtanding their ſeeming ſpongineſs, to ſink in common water, and continue at the bottom of it, without being manifeſtly diſſolv'd by that liquor, either in the cold, or by being kept a while in a moderate heat. I alſo found this ſubſtance fuſible, like bees-wax, at the flame of a ſmall taper; and if a lump of it were kindled thereat, it would burn away, partly with a yellow flame, and partly with a flame more intenſly blue than that of rectified ſpirit of wine; but it appeared apt to go out of it ſelf.

Theſe, and ſome other things, inclin'd me to look upon our anomalous ſublimate, as a ſubſtance *ſui generis*; yet ſuch an one, as I ſuſpected to be ſomewhat of kin to a *Sal volatile oleoſum*, as camphire ſeems to be. For our ſublimate riſes without a ſtrong fire, in a dry form, and is eaſily fuſible; all which I have obſerv'd in camphire, as well as in volatile ſalts: and our ſublimate will, like camphire, diſſolve in a high rectified vinous ſpirit, without at all colouring the liquor. And having long ſince found, by trial, that camphire will, tho' ſlowly, diſſolve in good oil of vitriol, and make the menſtruum look of a reddiſh brown; I put ſome of that ſolvent upon our ſublimate; and after having left them for ſome hours together, tho' in the cold, the liquor ſeemed to have diſſolved part of the dry body; having, by its action upon it, acquired a brown colour, ſomewhat inclining to red: and part of this liquor being put into a large quantity of common water, there ſeemed to emerge, by degrees, a dry body; or *flores*. But tho' I think it probable, that our anomalous ſublimate may be nearer of kin to a *Sal volatile oleoſum*, than to any of the chymical principles; yet I have not hitherto found the reſemblance betwixt it and ſuch a ſalt, to be compleat enough to make me poſitively refer it to any chymical product of a known denomination: and, therefore, till I am further ſatisfied, I ſhall only add, that this volatile ſalt, oily ſublimate, or whatever name it may deſerve, was very pretty to look upon; being glittering almoſt like ſome fine flowers of benzoin: and of this we had, tho' it were very light, between two and three drams.

Beſides all theſe different ſubſtances, our oil of aniſeeds afforded us, from time to time, a little quantity of ſpirit; as we concluded from two or three ſigns: one, that it came not over with the phlegm, and yet would mingle with that liquor, but not with the diſtilled oil: and another, that as it was more fixed than the oil and phlegm, ſo it roſe later than they; and not only needed a ſtronger degree of fire, but was uſually obſerved to come over in white fumes; as many ſpirits that are ſomewhat fixed do. And to ſhew more clearly, that this ſubſtance was a ſpirit; tho' it could not but be very much weakned, by being diffuſed through ſo great a quantity of phlegm as came over before it; yet its corpuſcles were ſo many and vigorous, that when put upon the powder of crude coral, they preſently began to diſſolve it; and the phlegmatic ſpirit in a trice made a great ebullition, with noiſe and bubbles, whether I poured it on the fix'd ſalt of tartar, or the urinous and volatile ſalt of ſal-armoniac.

Our experiment, therefore, argues, that a ſubſtance, looked upon by chymiſts as a homogeneous body, and which paſſes for one of their principles, may yet be of ſuch a nature, as barely, by the further action of the fire, to yield a very conſiderable proportion of a ſubſtance, exceedingly different from that which afforded it. For we obtained a *Caput mortuum*, whoſe qualities were quite different from thoſe of oil of aniſeeds; ſince it was opake, black, dry, very difficultly fuſible, and fixt, in ſo ſtrong a degree of fire as made the retort that contained it, and the ſand about it, red hot. This ſubſtance would lie undiſſolved in a highly rectified vinous ſpirit, into which oil of aniſeeds would readily have diffuſed it ſelf; without the help of heat. And tho' we made the liquor actually boil, for a long time, yet moſt of the *Caput mortuum* continued a black ſubſtance;

only it diſcoloured the menſtruum, which lookt as if it had rather extracted a tincture, than made a ſolution properly ſo called. And of this black and pitch-like *Caput mortuum*, we had, at the end of our diſtillations, when we weighed the ſeveral parcels together, not much leſs than half the weight of the whole oil of aniſeeds; the black matter amounting to conſiderably more than ſeven ounces. From hence we may gather, that the analyſis uſually acquieſced in by vulgar chymiſts, is as yet but an undetermined thing; ſince they have not declared what number of diſtillations ſhall be made the ſtandard; by which we are to conclude, that a ſubſtance, obtained by diſtillation, is a chymical principle.

It may be alſo inferred from ſome phenomena of our experiment, that the fire, as uſually employ'd, is not the true and genuine inſtrument of the analyſis of bodies; ſince it does not barely extricate and ſeparate the ſeveral ſimilar ſubſtances, that, tho' concealed and diſguized by mixing with each other, were pre-exiſtent in the body expoſed to its operation. For in our caſe, the oil of aniſeeds is, according to chymiſts, the ſulphureous principle of the concrete; and therefore, has not any other principles, eſpecially in any conſiderable quantity, contained in it: yet, by the bare action of the fire, this oil, which they acknowledge to be a ſimilar body, is brought to afford three or four other ſubſtances, of different natures from one another.

From theſe obſervations we may likewiſe deduce, that the fire, at leaſt in ſeveral caſes, may not only ſeparate, but variouſly compound and alter the parts of a body expoſed to its action; and thereby give cauſe to ſuſpect, that ſeveral ſubſtances, preſumed to be only extracted by the operation of the fire, may be really produced by it.

And agreeably to this, the ſubſtances obtained in our experiment, were, a fixt and earthy powder, a conſiderable portion of phlegm, a ſpirituous liquor, and a dry ſublimate, a-kin to a volatile ſalt: and theſe, tho' they all proceeded from a body, that, according to the chymiſts, ſhould not, and, indeed, for ought appears, did not actually contain any of them before; yet ſo reſemble, in qualities, the earth, phlegm, and ſpirit, that chymiſts obtain by diſtillation from thoſe bodies look'd upon by them as perfectly mixed and compounded, that they appear to be the ſame.

'Twill ſcarce be neceſſary to draw ſo obvious a corollary from what has been deliver'd, as, that 'tis poſſible for chymical principles may be made from one another.

But 'tis a conſiderable obſervation, that acid and aqueous ſubſtances, how different ſoever each of them is from a pure oil, may be produced from it by the action of the fire. For I found by trial, that in that liquor, which was taken for the phlegm of oil of aniſeeds, there was ſuch plenty of acid parts, that, as we before took notice,

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notice, they would readily diſſolve powdered coral, tho' crude, and in the cold; and would make a great conflict with ſalt of tartar, and with that of urine; yet the greateſt part of the liquor, by far, ſeemed to be of an aqueous nature, which a chymiſt would call phlegm; that is, a body that will not mingle with oil, and is otherwiſe exceedingly different from oil, eſpecially an eſſential one, whoſe purity makes it totally inflammable. And the quantity of the whole liquor, conſiſting of acid and phlegmatic parts, was far from being inconſiderable; amounting to about two ounces, and three quarters. It may alſo, be worth while to obſerve, that we may queſtion, whether it be neceſſary to ſuppoſe, with the chymiſts, that nature has made proviſion of great quantities of primordial and ſimple bodies; and that ſhe is ſolicitous to mix them all together, for the compoſing of a ſubſtance, capable of affording, by the analyſis of fire, ſalt, ſpirit, ſulphur, phlegm and earth. I will not hence univerſally infer, that there are no ſuch ſubſtances to be found, in any of thoſe bodies called perfectly mixed, antecedently to their being expoſed to the fire; but this, I think, will follow from what has been delivered, that the pre-exiſtence of ſuch ſubſtances, muſt be made out by ſome other way, than the bare operation of the fire; and that the grand chymical ſuppoſition will not univerſally hold, that what ſimilar body ſoever is obtained by the operation of the fire from a concrete, committed to diſtillation, was formerly and actually pre-exiſtent in it.*

And, laſtly, our experiment affords us a conſiderable argument in favour of that part of the mechanical hypotheſis, which teaches inanimate bodies to differ from one another, but in the magnitude, ſhape, motion, texture, and, in a word, the mechanical properties of the minute parts they conſiſt of. For in this experiment, we ſee that oil of aniſeeds, an uniform or ſimilar body, as to ſenſe, and judged ſo by chymiſts, upon an analyſis of the concrete that afforded it, is, by having its parts variouſly agitated, ſhook, and rubbed againſt one another, and in differing manners broken, aſſociated, and ranged, tranſmuted into four bodies of ſuch differing natures and qualities, as the chymiſts principles and elements are known to be; and this, without the help of any true ſeed, or plaſtic principle, by the bare operation of the fire; or by the bare tranſpoſition of the conſtituent parts, guided but by ſo ſimple, impetuous, and unruly an agent, as the fire: unleſs it be ſaid, that ſeveral particles of the fire ſubſtantially aſſociate themſelves with ſome parts of the oil of aniſeeds; and concur with them to compoſe the pitch-like *Caput mortuum*. Tho' it will not, perhaps, be thought likely, that igneous atoms ſhould, by their combination with the particles of an inflammable oil, produce an aqueous liquor, and that in great quantity; as we lately noted of the acid phlegm of aniſeeds, amounting to two ounces, and almoſt ſix drams.

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* 'Tis proved by M. *Homberg*, that the oil of metals will paſs into the ſubſtance of vegetables; and that vegetable oils will, in like manner, enter the ſubſtance of metals; that is, the ſulphur of bodies will change its ſtate indifferently, and paſs from one kind of ſulphur to another, according as circumſtances determine. *Memoir. de l'Acad.* A. 1710. p. 312.

Upon the whole, the phenomena obſervable in our experiment, ſeem very agreeable to the mechanical hypotheſis, and very unfavourable to that of the chymiſts. For, whether the fire be ſuppoſed to have acted merely as an agent, or efficient cauſe, or to have alſo concurred as a material one; it appears, that by changes of texture, without the addition of any viſible parts, or of any ſeed; bodies very different in colour, conſiſtence, fixedneſs, and many other qualities, may be produced from a ſubſtance not only homogeneous, as to ſenſe, but pure enough to paſs for a chymical principle.

Phenomena in the repeated diſtillations of other chymical oils.

When I framed the conjecture, that from a chymical principle, ſeveral different bodies might be obtained, by the meer operation of the fire; I endeavoured to confirm it, by making experiments upon other diſtilled oils, of natures different both from the oil of aniſeeds, and from one another. And, accordingly, whilſt our proceſs with this oil was carrying on, I took care to have diſtill'd, in the ſame furnace, oil of turpentine, oil of amber, and oil of hartſhorn.

Theſe oils were committed to the ſame perſon, who managed the oil of aniſeeds; and he, accordingly, kept a kind of journal of the number of rectifications, the quantities of pitchy matter, from time to time, afforded by them, and other phenomena, or circumſtances, that occurr'd in ſo tedious a proſecution, as I thought experiments of ſuch moment deſerved. The ſubſtance of this journal is as follows.

Two of theſe three oils, that of turpentine, and amber, and, probably, the third alſo, were diſtill'd at leaſt fifty times.

Each of the three left, from time to time, in the bottom of the retorts, whence they were drawn, a conſiderable quantity of black feces, much like thoſe left by the oil of aniſeeds. I, long after, found, in a paper, ſome of this matter left by the oil of turpentine; and, tho' I am not certain, whether it were all that was afforded by the pound of oil we employed, yet it amounted to above two ounces and five drams: and the other two oils did each of them afford a conſiderable quantity of black terreſtrial matter; tho' my aſſiſtant obſerved, that the oil of hartſhorn ſooner ceaſed to leave copious feces, than the oil of turpentine, or that of amber. But if neither of the two afforded any more than did the oil of turpentine; I look upon it as a remarkable thing, that the oil of aniſeeds, which is a fine eſſential oil, diſtill'd in a veſica, or limbec, ſhould yield above twice more of earthy matter, than any of the three other oils, that were diſtill'd but in retorts.

Of the colour of the rectified oil of hartſhorn I can ſay little, having unluckily loſt the liquor it ſelf; but the oil of amber, after the one and fiftieth diſtillation, was, indeed, very clear, yet of an amber colour, far from pale: and the oil of turpentine, that is uſually after one rectification, a clear and colourleſs liquor, after fifty diſtillations, appeared almoſt red.

But that is much more conſiderable, which I obſerved in the quantities of the different liquors, afforded by the long ſeries of our diſtillations; for at the end of the proceſs, the remaining oil of turpentine, for inſtance, did not appear to be conſiderably, if at all, ſuperiour in bulk to another liquor, that came over with it in diſtillation, and was not true oil; for it would readily enough mix with water, but keep it ſelf in a maſs diſtinct from the oil; and weighed above three ounces and three quarters.

This odd liquor I looked upon as compounded of ſpirit, and of phlegm; for tho' the latter did ſo much exceed the other in quantity, that with an expert chymiſt, the whole liquor paſſed for phlegm; yet I not only judged ſome parts of it to be ſpirit, but found them of an acid nature too; ſince, beſides what the taſt made me ſuſpect, the compound liquor would readily begin to corrode beaten coral, even in the cold; and ſome of it being poured upon good ſalt of tartar, preſently made with it a conflict and ebullition, not without a hiſſing noiſe, and a multitude of bubbles. So, likewiſe, the ſpirituous phlegm of amber, made a conflict with ſalt of tartar, and diſſolved crude coral, as other weak acid ſpirits do. This liquor of amber was not pale, as the phlegmatic ſpirit of oil of aniſeeds; and that obtained from the oil of turpentine was high-coloured, being of a browniſh red.

And among other trials made to examine, whether the ſpirits afforded by our oils, were really acid; we put two ounces of the ſpirituous phlegm of oil of aniſeeds, upon ſome minium; and, having digeſted them a while together, found the liquor turn'd ſweet, and fit to make *Saccharum Saturni:* and this liquor, after filtration, being gently abſtracted, left in the bottom of the retort, a thick, honey-like ſubſtance; from which (the diſtillation being continued with a much ſtronger heat) there came over ſome liquor; but being in too little quantity to be rectified, we could not free it from its phlegm, and, therefore, did not find it inflammable; as I gueſſed the ſpirituous part would have been after rectification; becauſe the liquor was exceeding like the *Spiritus ardens Saturni*, in its peculiar, and very penetrating taſt and ſmell.

Two vials, one containing ſome of the oil of turpentine, and the other ſome of the oil of amber, each of them diſtill'd at leaſt 50 times, having ſtood above a year and half to defecate; I was willing to try, whether theſe liquors would ſtill yield ſuch a black ſubſtance as before; and cauſing each of them to be again diſtill'd in a retort, they left a greater quantity of a black and ſhining ſubſtance, than could well have been expected.

It may ſeem very odd, that ſo volatile and thin a liquor, as a chymical and rectified oil, ſhould, by the bare operation of the fire, be brought to yield a great quantity of what appears ſo like terreſtrial feces, as our pitchy *Capita mortua.* For having put one ounce of the *Caput mortuum* of the oil of aniſeeds, and as much of that afforded by oil of turpentine, each of them into a diſtinct crucible, and kept them for near four hours, in ſuch a heat, as made the veſſels all the while red hot; tho' the crucibles were not cloſely covered, yet we found, when the veſſels were removed from the fire, that the contain'd bodies had not at all been brought to fuſion; only that from the oil of aniſeeds, was, in part, ſomewhat caked together: and, notwithſtanding all the heat they had been expoſed to, the pitchy ſubſtance of the oil of turpentine, retain'd near three quarters of its firſt weight; and the *Caput mortuum* of oil of aniſeeds loſt about eighteen grains leſs than that.

After this, we alſo endeavoured to diſcover, whether our pitchy ſubſtances would afford any fixt or alkaline ſalt, as the *Capita mortua* of moſt bodies belonging to the vegetable kingdom do. But tho' we kept an ounce of each of the black ſubſtances, left by the oil of aniſeeds, and that of turpentine, for nine or ten hours, red hot, in crucibles, we found, indeed, the bodies very much diminiſhed in quantity, but not at all calcin'd.

EXPERIMENTS
AND
OBSERVATIONS
Upon the producibleneſs of
CHYMICAL PRINCIPLES.

SECT. I.

The chymical principles not ingenerable and incorruptible.

THE pompous title of hypoſtatical principles, which chymiſts have beſtowed upon the ingredients whereof they would have mix'd bodies to conſiſt, has, perhaps, procured them a veneration from vulgar heads: but what principally recommends their doctrine to diſcerning men, ſeems to be this; that as by the help of a few, original, ſimple ingredients, join'd in different proportions, all mix'd bodies may be compounded; ſo, the natures of a multitude of them, ſeem, by this means, diſcoverable, from firſt knowing the natures of a few. He, therefore, who is unſatisfied with this hypotheſis of the *tria prima*, or that which alſo takes in water and earth, can ſcarce attack it more forcibly, than by calling their grand aſſertion in queſtion, and inquiring, whether theſe pretended principles are ingenerable and incorruptible; and whether nature only compounds and diſſociates, without either producing or deſtroying them. For if the bodies they call principles be produced *de novo*, how is it demonſtrable, that nature was obliged to take thoſe made ready to her hand, in order to compound a mix'd body? And how will it appear in every analyſis made by fire, that the ſalt, for inſtance, thereby obtain'd, was not produced from the chymical operations, but pre-exiſted in the body, in minute parts; (which, by the action of the fire, were only extricated and ſeparated from the other principles or ingredients, and afterwards brought together;) ſince, in caſe the chymical ſuppoſition be erroneous, not only the ſalt thus obtain'd, may be, in part, due to a new production, or tranſmutation, but ſome of that which was really ſalt, if any ſuch thing there were antecedent to the analyſis, might be either deſtroy'd by the operation, or made to appear under another form?

That ſalts may be produced and deſtroy'd.

Salt ſeems to be the leading principle with the chymiſts; and 'tis generally granted, that ſalts are the moſt conſiderable and active parts obtain'd by chymiſtry, from mix'd bodies; tho' the inviſible particles, that compoſe the viſible portions of a ſalt, may, perhaps, be ſuch, and ſo contriv'd, as to make other parcels of matter, which ſhall have thoſe qualities, on account whereof, the chymiſts call a body ſulphureous, or mercurial; as may be inſtanced in the inflammability of nitre. 'Tis therefore proper to enquire, whether ſalt, indefinitely ſpeaking, may be produced *de novo*, or deſtroy'd; and whether, at leaſt, the particular, and very different ſpecies of ſalts, may be chang'd into one another, and thereby, after a manner, be produced, in regard to the acquir'd ſpecies of ſalt; and deſtroyed in relation to that, which the ſame portion of matter before belong'd to.

Now, I muſt here obſerve two things; firſt, that as ſalts differ greatly in ſeveral properties, ſome being fix'd, others volatile, ſome acid, others urinous, *&c.* the two qualities, wherein they agree, and which, therefore, make up the receiv'd notion of ſalt, in general, are, that it is eaſily diſſoluble in water, and that it affects the palat, ſo as to cauſe the ſenſe of taſt. And ſecondly, whether we allow the *Epicurean* hypotheſis, or the *Carteſian*, the firſt ſaline concretions, produced by nature, muſt have been made of atoms, or of particles, that, before their conjunction, were not ſaline; and therefore, there is no abſurdity in conceiving, that by the action of the fire, or other fit agents, ſmall portions of matter may be ſo broken into minute parts, and theſe ſo ſhap'd and connected, as, when duly aſſociated, to compoſe a body, capable of diſſolution, in water, and of affecting the organs of taſt.

That a diſpoſition to be diſſoluble in a liquor, may be acquired by mixture, and a new texture of parts, appears from hence, that tho' powder'd ſulphur will long lie in well rectified ſpirit of wine, without being at all viſibly diſſolv'd therein; and tho' the ſame liquor will, for as long a time, ſwim upon ſalt of tartar, without making a ſolution of it; yet if the ſalt, and ſulphur, be mix'd together, the ſame ſpirit of wine will, in leſs than an hour, diſſolve enough of them, to be highly colour'd thereby, even without the help of external heat. Why then ſhould it be impoſſible, for the fire to reduce the corpuſcles of bodies to ſuch a minuteneſs, and aſſociate them either among themſelves, or with the corpuſcles of other bodies (which, before preparation, will not diſſolve in water;) ſo that the pores, intercepted between them, may be enter'd, and their looſe texture diſſolv'd by that fluid? Cryſtals of well purified ſalt-petre, may be kept dry, for many months, in an ordinary chamber; yet, if without the addition of any body, diſſoluble in water, or the moiſt air, it be, in part, reduced, as perhaps it may be almoſt in a trice, to a fix'd alkali; this ſalt will be eaſily penetrable by the vapours that float in the air, and by this moiſture ſoon be brought to relent, and at length, to diſſolve into a liquor analagous to *Oleum tartari per deliquium*.

As for the ſapor of a ſaline body, I doubt, whether the neceſſity of it be conſiſtent with another principle, and with experience. For even thoſe pure oils, called eſſential, or etherial, are highly ſapid; yet as theſe will not diſſolve in water, there appears to be no ſtrict connection betwixt being ſapid, and being ſoluble in that fluid: whence, if bodies be reduced into a multitude of parts minute, and ſharp enough; 'tis very poſſible, that ſome of them may acquire a ſhape and ſize that fits them, ſenſibly to affect the organ of taſt, tho' the bodies themſelves are rather of another nature, than of a ſaline one. Thus a ball of glaſs, while entire, will not hurt the skin; but pricks it, and cauſes pain, if broken into little ſharp fragments. And the like, perhaps, may happen in the organs of taſt: for ſalt-petre, tho' it have but a faint and languid taſt; yet if carefully diſtill'd, with an addition, not diſſoluble in water, and inſipid; the parts of it being, by the action of the fire, broken aſunder, rubb'd, or ground againſt one another, till they are reduced to edged and pointed corpuſcles, will be reſolv'd into different ſubſtances; each whereof has an extremely ſtrong and piercing taſt. Now, whence this ſhould proceed, but from ſuch a mechanical change, as we have deſcrib'd, is not eaſy to ſay: and, perhaps, alſo, the watry liquor, that comes over in this analyſis, may be produced by the operation of the fire; and the phlegm being inſipid, ſo much taſt as was in the entire nitre, may be as well deſtroyed, as thoſe of the ſpirit and alkali are generated by the ſame agent. But, perhaps, there needs no other argument to ſhew, that the ſame parts of matter, according to its different ſtates, may have the qualities which chymiſts attribute to their particular principles, than our obſervation upon chymical oils, which more ſtrongly affect the taſt, than moſt ſalts themſelves. And *Helmont* aſſures us, that by *Paracelſus*'s *Sal circulatum*, ſolid bodies, among which he particularly inſtances ſtones, may be tranſmuted into actual ſalt, equal in weight to the body whereof it was made. So that, as the chymiſts ſuppoſe, there is in theſe mix'd bodies, ſulphur, mercury, and a *Terra damnata*; the ſame portions of matter that pre-exiſted in the form of thoſe ſimple ingredients, muſt, by the operation of the fire, and an anomalous menſtruum, have been turn'd into ſalt: and if the *Helmontian* experiment be allow'd good, we may ſafely conclude, whatever becomes of the chymical ſuppoſition, that ſalt may be made of matter which was not ſalt before, and conſequently, that ſalt may be produced *de novo*.

The ſalts, properly ſo call'd, that appertain to our preſent enquiry, ſeem to be chiefly the acid ones; ſuch as vinegar, ſpirit of ſalt, &c. the alkaline or fix'd lixiviate ſalts, made by calcination; ſuch as ſalt of tartar, of wormwood, &c. and laſtly, the volatile and urinous ſalts, ſuch as thoſe of harts-horn, of urine, of blood, &c. which taſt and ſmell, like that of urine. If, therefore, we can ſhew, that theſe may be produced *de novo*, or tranſmuted into one another, we ſhall prove the common chymical doctrine of principles falſe.

Shewn in the acid kind.

To begin with acid ſalts; we ſee that even ſweet wines often, of themſelves, degenerate into ſour vinegar, which will diſſolve coral, ſeveral ſtones, calcined lead, and other minerals. The water imbibed by the roots of trees, is, in thoſe that bear lemmons and barberries, changed into liquors abounding with ſaline corpuſcles, that enable them to affect the organs of taſt, and act as acids on pearls, &c. Guaiacum, alſo, and ſeveral other woods, that do not taſt at all ſour, will, by being diſtill'd in retorts, afford ſpirits plentifully furniſhed with acid particles, which, as I have tried, hiſs upon alkali's, diſſolve coral, and even lead it ſelf, calcined into minium, and make *Saccharum Saturni* of it. Many other vegetable bodies, alſo, do, without addition, afford the like acetous liquors. If it be objected, that theſe pre-exiſted in the bodies whence they proceeded, and were only extricated by the operation of the fire; I expect that this ſhould be prov'd; for the ſweeteſt bodies, and thoſe of different kinds, as ſugar and honey, afford a ſort of ſpirits, which are ſharp and piercing. And in ſeveral caſes, where we are ſure that acid ſpirits were plentiful ingredients of a compoſition, as in *Saccharum Saturni*, and that magiſtery, called ſalt of coral, &c. experience ſhews, that the liquor which comes over, by diſtillation in retorts, is not acid, but quite of another kind. I would not hence be concluded to deny, that acid ſalts may in ſome mixed bodies, be ſo aſſociated with others, and obſcured by them, as not to be diſcernable to the taſt, till they are ſeparated by the operation of the fire. But to ſhew, that acid ſalts were *de facto* pre-exiſtent, as acid ones, in the body that affords them, there muſt be ſome poſitive proof, other than the liquors diſtill'd from them; ſince they, as we have already argued, may be not barely extricated, but have their acidity produced by the operation of the fire. And ſaltpeter, tho' it have no acid taſt, may be made to afford, by diſtillation, above three quarters of its weight of a highly acid liquor; yet it appears not, that ſuch a great proportion of acid particles, or poſſibly any conſiderable proportion at all, is employed, by nature, in the compoſition of nitre. Nor ought it to ſeem incredible, that acid ſalts, as well as others, ſhou'd be producible by the various ſeparations, attritions, coalitions, and changes of texture, which may be cauſed ſeveral ways; and eſpecially by the operations of the fire, that makes a vehement and various agitation of all the minute parts of a body, and may therefore eaſily ſplit or break ſome of them, and, as it were, grind others againſt one another, and in ſhort, ſo alter their bulk, figure and motions, as to make them fit to ſtab or cut

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In the volatile. We have an eminent inſtance of the production of volatile ſalts in the ſalt obtainable, by diſtillation, from ſoot; for tho' the wood we burn in our chimneys, ſeems to have nothing of the taſt, or ſmell of urinous ſalts; nor the diſſolutions of the ſaline parts of ſuch wood been obſerv'd to have any affinity, in taſt or odour, with the ſalt of ſoot; yet when wood is firſt burnt in the fire, and then the ſoot afforded by it, duly diſtill'd and rectified in proper veſſels, there is obtained a ſpirit, and a white volatile ſalt, that in ſmell, and taſt, and ſeveral operations, appear to be nearly allied to thoſe of human blood, or urine, and may eaſily be miſtaken for them.

But this double operation of the fire is not always neceſſary to the productions of volatile ſalts out of vegetables; for tho' by diſtilling them in retorts, we generally obtain no dry ſalt, but a ſouriſh ſpirit, with which I have diſſolv'd coral, lead, and other hard bodies, that urinous ſpirits wou'd not work on; and tho' being put upon urinous ſalts, they make a great hiſſing, and conflict; yet I have from muſtard-ſeed, that had been kept for a convenient time, obtained, by diſtillation, a volatile ſalt that faſtened it ſelf prettily, in figured grains, to the upper part of the receiver, and this at the very firſt diſtillation; ſo that there was no need of rectifying the diſtill'd matter to ſeparate that ſalt. And by an eaſy way we may, out of very many vegetables, firſt duly prepared, without adding any thing to them, by bare diſtillations in retorts, obtain plenty of volatile ſpirits and ſalts, which, by their fugacity, colour, ſmell, taſt, *&c.* prove ſo like the ſalt and ſpirit of urine, ſoot, *&c.* that he who knew nothing of the manner wherein they were made, wou'd readily conclude they belong'd to one or other of thoſe ſorts of bodies.

I have, alſo, ſometimes produced a volatile ſalt, which wou'd readily be pronounced urinous, from a mineral it ſelf; nor was this the only foſſil from which experience aſſures me, ſalt of this kind is obtainable.

It is not univerſally true, that ſaline ſubſtances, which appear volatile, and aſcend in the form of ſalt, are of an urinous nature, and enemies to acids. For I have had from verdigreaſe, diſtill'd *per ſe*, with a ſtrong fire, a very acid ſpirit, which being warily rectified, afforded firſt a ſour phlegm, and then a piercing ſpirit, ſharper than it; leaving behind, in the veſſel, ſome few ſpoonfuls of a dark colour'd liquor; which, being ſet aſide, and ſuffered to reſt, did, in great part, ſhoot into tranſparent cryſtals, large, thin, and almoſt like thoſe of ſilver diſſolv'd in *Aqua fortis:* they appeared prettily figured at the edges, but were ſo odly connected among themſelves, that I could not refer them to any of the known geometrical figures; and their brittleneſs made them the leſs tractable; but their ſmell, which was ſtrangely piercing, and not inoffenſive, argued them to be of the ſame nature with the acid ſpirit which had come over with them.

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But there is a more conſtant and eaſy method of producing ſuch a volatile ſalt; for, if amber be gradually and carefully diſtill'd, it will afford, beſides the phlegm, ſpirit, and oil, a dry ſubſtance; which, tho' the chymiſts call the volatile ſalt of amber, I found to be really of an acid nature, upon ſeveral of thoſe trials, by which we diſcern a body belongs to the family of acids.

And in the alkaline, or lixivius.

The laſt ſort of ſalts to be ſhewn producible, are the alkaline, or fix'd, which ſeem oppoſite to acid ones; making a conflict with them, and performing ſeveral operations contrary to theirs.

As to the origin of theſe fix'd ſalts of calcined bodies, the chymiſts are not of one mind: the moſt univerſal opinion, before *Helmont*'s time, and even of later chymiſts, ſeems to have been, that theſe fix'd alkalies pre-exiſt in mix'd bodies; and that the fire only ſeparates, or extricates them from the parts of the compound. But *Helmont* has ingeniouſly conjectured, that theſe lixiviate ſalts do not pre-exiſt, in their alkaline form, in the bodies that afford them; but are productions of the fire, by whoſe violent action, a part of the ſalt, which, in the concrete, is naturally all volatile, lays hold of ſome parts of the ſulphur of the ſame body, and ſo, both together are melted, and fix'd into an alkali; which fixation he exemplifies, by what happens when ſalt-petre and arſenic, tho' both volatile, being expoſed to the fire, are, by its operation, flux'd, and made to fix each other. But I doubt, whether this account be clear and ſatisfactory; eſpecially if 'tis applied to all fix'd alkalies. For it may be queſtion'd, whether it has yet been prov'd, what *Helmont* teaches, that all the ſalt of mix'd bodies, before their combuſtion, is volatile: nor is it declared what volatile ſalt is meant; tho' it be plain, that ſome bodies, which afford a fix'd ſalt, abound in acid ſpirits, as oak, box, *&c.* and others, as hartshorn, blood, *&c.* abound in urinous ſalts, that exerciſe hoſtility with acids. And from ſome bodies I can obtain both acid ſpirits, and ſuch as are called urinous. 'Tis not eaſy to explain, how the volatile ſalt comes to unite it ſelf ſo intimately with the oil; and, tho' this be alſo volatile, to compoſe with it a body able to endure the violence of the fire; ſince we have more than once try'd, that the volatile ſalt of urine, or of hartſhorn, and a chymical oil, as of turpentine, or the like, being put together, the ſalt will, indeed, aſſociate to it ſelf ſome particles of the oil; but will, nevertheleſs, with them ſublime, by a very gentle fire, in the form of a ſalt. And the example that *Helmont* gives of arſenic and nitre, ſeems unſatisfactory; becauſe, upon mixing equal parts of thoſe two bodies, and, in a ſtrong crucible, fulminating them together, a great part of the mixture was driven away by the fire, ſo little alter'd, that 'twas very dangerous to be too bold with the fumes; and a large part of what remained, was fix'd only in compariſon of the crude arſenic, but not comparably to ſalt of tartar, or other true alkali: and the conſtancy of the part that was more fixed, may, probably,

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bably, be aſcribed to the ſalt-petre; which we know will, without the help of arſenic, afford a great deal of fixed ſalt, if about half of it be burnt away by the help of powder'd charcoal, or ſome other convenient ingredient. It alſo weakens this inſtance of *Helmont*'s, that there are other inſtances in which we obſerve no ſuch thing happen, as his hypotheſis would make one expect. For, common ſulphur is by chymiſts ſaid to abound in an oily part, upon whoſe account it is very inflammable; ſo that they would have other inflammable bodies to hold that property, by participating of ſulphur. That this concrete, alſo, abounds in ſalt, is evident, according to their principles, by the acid menſtruum it affords, which goes under the name of *Oleum ſulphuris per campanam*. Yet theſe ingredients, combined by nature, make up a concrete, which both in cloſe veſſels, and the open fire, is almoſt totally volatile. And in that mixture of the highly dephlegmed ſpirits of wine, and of urine, that *Helmont* calls the *offa alba*; tho' the urinous ſalts manifeſtly combine with the ſpirit of wine, which, being totally inflammable, the chymiſts refer to their ſulphur; yet the coagulated part does not, by this aſſociation of ingredients, grow fixed, but proves very volatile. It might here be urg'd, in favour of the common opinion of the pre-exiſtence of alkalies in mixed bodies, firſt, that there is no need to ſuppoſe a colliquation of ſalts, with ſulphurs, oils, or any thing elſe, to produce fixed ſalts; ſince that ſuppoſition does not explain, how two volatile bodies come to compoſe one that is fixed; and ſince 'tis plain, that a body yet more fixed, may be made without any aſſociation of different principles. For, the earth, that, together with the alkali, remains in the aſhes of a burnt body, is more fixed than the alkali it ſelf; and yet derives not its fixity from any combination of elements, or principles, but from the groſſneſs, ſolidity, or weight, and unfitneſs for avolation, in the corpuſcles it conſiſts of. Secondly, ſome inſtances are alledg'd, wherein there is ſuppoſed a diminution of the quantity of the fixed alkali of the concrete, by operations that are ſaid to carry off the volatile ſalt, before the body comes to be incinerated. But, it may be anſwer'd, that, perhaps, thoſe various operations did but rarifie and volatilize part of the pre-exiſtent alkali, and ſo left the leſs of it to be recovered by calcination; as, the chymiſts tell us, fermentation rarifies the oily parts of the juice of grapes, and ſubtilizes them into vinous ſpirits, and ſo, greatly leſſens the quantity of the oil. And thus, when wood is burnt in a chimney, 'tis not in the form of an acid ſalt, which is the only one commonly obſerv'd to be driven away by diſtillation in cloſe veſſels, but in the form of an urinous ſalt, that the ſaline part of the wood is made to aſcend; as may appear by the diſtillation of ſoot. But inſtead of inſiſting on theſe arguments, we need only obſerve, that tho' by diſtillation, or any other known way of treating ſalt-petre, there is no oil to be ſeparated from it; yet above half the body of it may be eaſily and quickly turn'd into a fixed ſalt, in colour, taſt, and operation, much like that of tartar, and other incinerated vegetables. And ſuch an alkali I have made, without the help of injected coals, or any other body furniſhed with a combuſtible ſulphur; ſo that it ſeems not univerſally true, that to the production of an alkali, there is neceſſary to be at hand, an oil or ſulphur, to be laid hold on by the volatile ſalt, and fixed together with it. But this experiment is far more agreeable to our doctrine, which derives all thoſe ſalts from the ſize, ſhape, and ſolidity, or weight of the ſaline corpuſcles; ſince the ſame ſalt-petre, whoſe greater portion, by the foreſaid operations, will be reduced to a fixed alkali, may, by being diſtill'd with a convenient bole, have its greater portion brought over in the form of an acid ſpirit, or ſalt; which it ſelf may afterwards be made to concur, materially, to the production of an alkali. I might add, that even from one of *Helmont*'s own experiments, this concluſion follows; for he affirms, that by the addition of more alkaline ſalt, and the operation of the fire, the earth it ſelf that is in the aſhes, may be turn'd into ſalt: which, if true, argues, that a fixed ſalt may be made of what was not before either of a ſaline, or of an oleaginous nature; and, conſequently, without any ſuch combination of ſalt and ſulphur, as his hypotheſis ſuppoſes. From this experiment I may, alſo, infer the poſſible origin of alkalies, by the mechanical changes, that, without the addition of oil or ſulphur, the operations of the fire produce in the parts of a mixed body; ſince earth ſeems the moſt indiſpoſed of any part of the concrete, except water, to be turn'd into fixed ſalt.

Egyptian nitre, *a native lixivious ſalt, or alkali.*

I muſt not here omit an obſervation I have made, which ſeems to overthrow the opinion of thoſe, who will have the violence of the fire to be always a neceſſary agent in the production of a fixed or lixiviate alkali. Having ſome ſalt, ſent for a preſent out of the *Eaſt*, to a nobleman, who had been ambaſſador for his *Britiſh* majeſty at the *Ottoman* court, and affirm'd to be the true *Egyptian* nitre, ſo much talk'd of by the ancients; I found it to agree much better with the notion books had given me of it, than with that ſort to which chymiſts generally give the name of nitre, and which, indeed, is the only nitre to be uſually met with in our ſhops.

This ſalt, I found, was very apt to imbibe the moiſt air, as calcin'd tartar, and other fixed alkalies are. But what makes to our preſent purpoſe was, that having upon this crude *Egyptian* nitre poured ſpirit of ſalt; the acid liquor preſently, even in the cold, work'd briskly upon it, as if it were a fix'd alkali. And hence, by the way, we ſee the juſtneſs of that expreſſion of *Solomon*, when, to repreſent things very incongruous to one another, he mentions the diſagreement of vinegar and nitre; for preſuming that *Solomon*, who reigned in *Judea*, a country near to *Egypt*, and had much commerce with the *Egyptians*, made uſe of their nitre, as the beſt, if not the only ſort known in his time and country; and finding that nitre is mention'd by the prophet *Jeremy*, as a very abſterſive thing, and fit to cleanſe womens skins, which is a known virtue of fix'd alkalies, but no more than the former obſerv'd in common ſalt-petre; I pour'd upon it ſome ſtrong vinegar, and found, as I expected, that there preſently enſued a manifeſt conflict, with noiſe and many bubbles. Hence it appears, that *Egyptian* nitre, acknowledg'd to be a native ſalt, and made only by the evaporation of the ſuperfluous water of the *Nile*, is yet of a lixiviate nature, or, at leaſt, abounds with particles that are ſo; tho' produced without precedent incineration, and the matter of it expos'd to no violence of the fire, to make it afford an alkali.

I pretend not, however, to ſay, that alkalies may not be produced in multitudes of mix'd bodies, eſpecially in many vegetables, after the way propoſed by *Helmont*. It will ſuffice, for my purpoſe, if ſome bodies, belonging to this family, or kind of ſalts, may be produced at all. And, tho' I do not aſſert, that all fix'd alkalies are productions of the fire, or made by the help of it, yet I do not remember any, except *Egyptian* nitre, but what are.

An alkali made from ſea-ſalt.

Chymiſts, generally, look upon ſpirit of nitre, and *Aqua fortis*, as containing not alkaline, but acid ſalts; which they conclude from the taſt, as well as from the great ebullition that is made, when thoſe liquors are pour'd on ſalt of tartar, fix'd nitre, pot-aſhes, or other unqueſtion'd alkalies. That ſea-ſalt, likewiſe, contains no alkali, is generally allow'd; the ſpirit of it being juſtly reckon'd among the acid ones: and when I purpoſely examin'd that concrete, by diſtillation, the remaining ſalt, tho' the fire had been violent, was very different from alkalies; yet, I, ſeveral times, made the following experiment with ſea-ſalt, that retain'd all its acid ſpirit. Upon well-dry'd, and powder'd ſea-ſalt, plac'd in a retort, we pour'd ſometimes an equal, and ſometimes a double weight of good ſpirit of nitre, or *Aqua fortis*; and leiſurely diſtilling all that would come over, we took out the dry ſalt, remaining at the bottom; which we found much chang'd, both as to colour and taſt. This ſalt, being again powder'd, and put into a crucible, placed in a convenient fire, was, by the repeated injection of well-kindled charcoal, made to flaſh ſeveral times, almoſt like melted nitre; and when it would flaſh no longer, the remaining matter, being taken out, did, in great part, appear of an alkaline nature; for it had a fiery taſt; and if ſpirit of nitre, or *Aqua fortis*, were poured thereon, it would make an ebullition: it turn'd ſyrup of violets green, and, in ſhort, exhibited various phenomena of alkaline ſalts.

Others from ſalt-petre.

There is another way of making an alkali out of nitre, thus: pour upon it an equal weight, or half the weight, of ſtrong oil of vitriol; and having diluted the mixture, with a convenient proportion of fair water, diſtil it, by degrees, till there remain a very dry ſubſtance; powder this, and mix it well, with about an eighth part of beaten charcoal; keep them in fuſion, in a ſtrong cloſe crucible, till the maſs grow very black, and a little of it being taken out, with a wire,

Chymiſtry.

taſts fiery; then, take out the mixture, which will very eaſily imbibe the moiſture of the air, and you will find it, at leaſt while 'tis hot and dry, of a more fiery lixiviate taſt, than ſalt of tartar it ſelf. It will make an ebullition with acid ſpirits, and precipitate ſeveral ſolutions made with them; it will turn ſyrup of violets green, and, in ſhort, diſcover it ſelf, many ways, to be of an alkaline nature; tho' it be aſſociated with a ſulphur, that may, by various methods, be made appear to be plentifully contain'd therein.

It is, alſo, remarkable, how the ſame body, without the addition of any other ſalt, may, by varying the manner of the fires application to it, be made to afford either little elſe than acid ſalts, or a leſſer or greater quantity of alkali. For, if fine ſalt-petre be dexterouſly diſtill'd, with about thrice its weight of ſome proper earth, not powder'd bricks, it will, ſometimes, afford very near as much ſpirit of nitre, as the ſalt weigh'd; and tho' this, like other liquors, be not without phlegm, yet it may be doubted, whether moſt of it were not produc'd by the tranſmuting operation of the fire: however, we may ſuppoſe, that five parts of ſix, or ſix of ſeven, have been diſtill'd into dephlegm'd ſpirit.

But, if by frequent injecting into flux'd ſalt-petre, ſmall pieces of kindled charcoal, till it will flaſh no more, fix'd nitre be made; you may obtain therefrom, half its weight of an alkaline ſalt, that many would, by its taſt and operations, gueſs to be ſalt of tartar.

But, farther, to ſhew, how much the production of this alkali depends upon the operation of the fire, which, as 'tis variouſly applied, may vary the texture of the ſalt-petre; I made the following experiment. We took a pound of good ſalt-petre, groſly beaten, and having laid it in a conical heap, upon a flat tile, that the air might, on all ſides, have acceſs to it, we cauſed the upper part of it to be kindled by a little fragment of burning coal; then, with an iron rod, we dexterouſly ſtirr'd the kindled part of the nitre, that the ignition might, preſently, be communicated to as many parts of the ſalt as poſſible: and this nimble agitation of the maſs, was continued to the end of the operation; by which method, within few minutes, we obtain'd, more than once, out of 16 ounces of ſalt-petre, 10 ounces of fix'd nitre, very lixivial in taſt and operation, and of a pleaſant greeniſh blue colour, deeper than ſalt of tartar will uſually be brought to, by being, in a crucible, kept twenty times as long in a ſtrong fire.

This experiment ſhews what quantity of alkaline ſalt is, by a different operation of the fire, obtainable from crude nitre; which, in a diſtillation, ſkilfully made for the purpoſe, may be, in great part, driven over in the form of acid ſpirit and phlegm, ſo as to leave a ſurprizingly ſmall quantity of true alkali behind it. Nay, ſometimes, I could ſcarce find any at all, tho' I purpoſely try'd to ſeparate it from the tobacco-pipe clay, wherewith the ſalt had been mix'd; and this, after a diſtillation, wherein not half of the nitre had been driven into the receiver in the form of ſpirit.

And, to ſhew, that to make the fix'd ſalt of nitre, the actual inflammation of it in the open air, is not neceſſary; and that 'tis poſſible to make an alkali of nitre, tho' no combuſtible body be added to kindle the corpuſcles of the ſalt by its ſulphur; and, by the aſſociation of ſome part of the ſulphur, with the ſaline parts of the nitre, to compoſe an alkali; I more than once, with a convenient quantity of good ſalt-petre, carefully mix'd about an eighth part of tobacco-pipe clay, and putting the mixture into a crucible, cloſely luted at the top, we kept it, by a graduated fire, in fuſion for ſome hours; and found, that the remaining ſalt was turn'd into an alkali, of a fair blue colour, like the better ſort of that fix'd nitre, which is made with charcoal. Theſe two experiments ſeem plainly to argue, that to the making of fix'd nitre, which is confeſs'd to be an alkali, a proper change of texture may ſuffice; whether that change be attempted in open veſſels, or in cloſe ones, with, or without the addition of the ſulphur of charcoal, or any other combuſtible body. I, alſo, ſucceſsfully attempted to make an alkali of ſalt-petre, by melting moderate quantities of it, ſeveral ways, and keeping it in fuſion, with ſome metals. And to obviate the ſuſpicion, that ſome chymiſts might have, of the material concurrence of a large portion of the combuſtible ſulphur, preſum'd to be in the ignobler metals, to the production of the nitrous alkali; I ſhall add, that our experiment ſucceeded, when we made it, more than once, with very fine ſilver, whoſe ſulphur, if it have any, is granted to be fix'd, or incombuſtible. And, I remember, the laſt trials afforded us a bluiſh alkali, tho' there were employ'd a fifth part of ſilver in proportion to the nitre; and tho' the fire was ſo moderate, as not to melt the metal, that was in thin plates: and of an ounce put in, there wanted but four grains; which ſmall loſs, might well be imputed to accidents.

Alkalies tranſmutable into other ſubſtances.

And as lixiviate ſalts, and alkalies, may thus be produced, by the operation of the fire; ſo, may they be deſtroy'd, or depriv'd, of their alkaline form, and turn'd into a ſubſtance of a nobler nature, by the ſame. We took a tolerable quantity of a good ſalt of tartar, that had been purified by ſolution and coagulation; and having put it into a clean crucible, we kept it in a ſtrong fire, that made the crucible red hot, for a conſiderable time; then, at length, giving it a ſtronger fire, we poured it out, and again diſſolv'd as much of it as we could in cold water, which being ſet to run thro' cap-paper, there appear'd in the filtre, a moderate quantity of matter, that would not diſſolve in the water, but was turn'd into a kind of earthy ſubſtance; then re-coagulating the ſolution, that had paſs'd thro' the filtre, into dry ſalt, we again expoſed it in the crucible to a ſtrong fire; and putting it into freſh water, we perceived it would not totally diſſolve, but left, in the filtre, a ſlime, or mud. And, in this manner, we proceeded to ignite, diſſolve, filter, and coagulate the ſame ſalt of tartar for ſixteen times, and ſtill found ſuch an earthy ſubſtance remaining in the filtre; and the reſt of the ſalt of tartar ſo little altered, that I concluded it highly probable, the remaining part might, by the ſame way of management, be brought to yield more and more of that ſame ſubſtance, which either was earth, or of kin to it; being ſomewhat of a nature very different from ſalt of tartar; ſince it was not fiery on the tongue, and indiſſoluble in water.

It may illuſtrate, and add probability to what we have ſaid about the produciblneſs of ſalts, to conſider the compoſition and re-compoſition of ſaline particles, and their operations on other bodies, and on one another. For if it appear, that by theſe manifeſt and mechanical ways, ſuch alterations may be made, and ſuch qualities produced, as are either altogether, or very near as conſiderable as thoſe which diſcriminate the ſeveral families of ſalts from one another, and from the chymical principles, it will be judged the more credible, that theſe families of ſalts may be either tranſmuted into one another, or otherwiſe produced.

Common ſalt producible.

To ſhew that common ſalt it ſelf, which ſeems the moſt primitive and ſimple among groſs and viſible ſalts, may be produced by a change of texture made in bodies very different from it; I ſhall recite an experiment, which tho' it have ſometimes failed me, yet it has often anſwered my deſire.

Sandiver is a recrement made when, the materials of glaſs having been firſt baked together, and then kept long in fuſion, the mixture caſts up the ſuperfluous ſalt, which the workmen afterwards take off with ladles. This ſalt, tho' ſeldom uſed by mineraliſts, and ſcarce mentioned by the writers of courſes in chymiſtry, I have employed to ſeveral purpoſes. For herein we have a ſalt, which was once altogether lixiviate; and which, by being kept long melted in a ſtrong fire with the ſand, muſt have had its ſaline corpuſcles variouſly and forcibly ground or rubb'd againſt one another, and againſt the particles of the ſand; ſome of which it may alſo diſſolve and retain: however, by theſe rude juſtlings and mutual attritions, I thought it very probable, that the alkali muſt have been variouſly and conſiderably altered; ſo that ſandiver may conſiſt of portions differently qualified, both with regard to the lixiviate ſalt that was at firſt employed, and to one another.

We diſſolv'd a conſiderable quantity of good ſandiver in fair water, filter'd the ſolution, and ſet it to evaporate in a digeſtive furnace, till a ſaline cruſt ſpread it ſelf upon the top of the liquor; then ſuffering it to cool and cryſtallize, we broke that cruſt, to come at the cryſtals, and ſet the liquor, we had poured off from them, to evaporate further, and ſhoot again; and in this method we proceeded as long as we thought proper: by this means we obtained many cryſtals, whoſe figures were not the ſame, tho' moſt of them tranſparent and prettily ſhap'd; but the chief thing for which I mention this experiment is, that by proceeding thus, I more than once obtained, not on the very ſurface of the water, as is uſual in the concretions of ſea-ſalt, but in other parts, and chiefly beneath the ſurface of the ſaline cruſt, a conſiderable number of grains of ſalt, that better anſwered to the deſcription of common ſalt than diſſolv'd and filter'd ſea-ſalt it ſelf; for theſe grains were large, and as like little cubes, as if they had been made by a skilful jeweller; and their ſurfaces had a ſmoothneſs and gloſs much ſurpaſſing what I had ever obſerved in common ſalt.

I may confirm the difference I have mentioned, to be between ſandiver and common alkalies, by this, that having ſet a large quantity of the filter'd ſolution of ſandiver to coagulate in a cool place, and thereby brought a great part of the ſalt to coagulate into cryſtals, almoſt like thoſe of nitre, but ſo very diaphanous, that ſeveral of them were clear as rock-cryſtal; I did not obſerve them to relent by the moiſture of the air, in a long time, tho' the glaſs they were kept in, was negligently covered with paper only: which argues their texture to have been remote from that which is proper to alkalies; and ſhews them to be, alſo, ſalts of a peculiar nature. If they were expoſed to a gentle heat, they would, in no long time, loſe their tranſparency, and be reduced to a fine white calx, which being weighed, and again diſſolv'd in water, and made again to cryſtallize, would be tranſparent, and coagulate with it ſelf ſo much of the water as gave a very notable increaſe of weight.

Sandiver is by ſome reckoned an artificial body; my ſecond inſtance, therefore, ſhall be in a body that ſeems natural. If human urine, after having been kept for ſome weeks in a cloſed veſſel, be expoſed to a moderate fire, it will firſt yield a ſpirit and a volatile ſalt, then a large quantity of phlegm, which being totally exhaled, there will remain a dry *Caput mortuum*; and this being warily calcined, diſſolv'd in water, and coagulated, if the experiment ſucceed, you will find the ſalt very different from a common lixiviate alkali; or rather, the ſaline concretions will differ in form, if not in kind; for I obſerved ſome to be oblong, and to look like ſmall cryſtals of nitre, but others rhomboidal: and one of the faireſt of the latter, I kept, for many days, expoſed to the air; and that in winter, without finding it run *per deliquium*; as a piece of common alkali of that bigneſs wou'd have done, in a ſmall part of the ſame time. But beſides thoſe numerous ſaline concretions that I cou'd not eaſily reduce to any known figure, there was a conſiderable number of fine grains, reſembling common ſalt; and were, indeed, more exactly cubical in their figure, than the grains of ſea-ſalt. And I have the leſs cauſe to doubt, that the ſea-ſalt, abounding in our *Caput mortuum*, was not a common lixiviate alkali, becauſe the *Caput mortuum*, when expoſed to calcination, began early to melt in the fire, before it was near calcined, not like an alkali, but ſea-ſalt; becauſe the taſt was much nearer to that of brine, than to that of lixivium; and, laſtly, becauſe it would make no conflict with the ſpirit of ſalt, as an alkali would have done; but with a ſolution of ſilver in *Aqua fortis*, gave a white precipitate. Having diſſolved, and filter'd a large quantity of this ſalt of urine, and ſuffer'd the ſolution to evaporate ſlowly, till it began to have a ſkin; I found the cryſtals it afforded, in a cool place, to be, ſome of them an inch or two long, and ſhaped almoſt like cryſtals of nitre, only they were ſharper at both ends; and to many of them were faſten'd abundance of minute and oblong cryſtals, prettily ſhaped, and placed almoſt perpendicularly upon the greater portions of ſalt. Theſe cryſtals, as they did not reſemble common alkalies in figure, ſo they were unlike to them in other reſpects; for tho' oil of tartar *per deliquium*, being poured upon ſome of them, there enſued no manifeſt commotion, as happens when that liquor is mix'd with a ſalt, where an acid is predominant; yet being beaten, and mix'd with an acid ſpirit, as that of common ſalt, they made not the leaſt ebullition, or conflict, tho' they were ſtirr'd up and down to excite it. Nor did *Aqua fortis* produce any hiſſing noiſe, or froth, when it was put upon the ſalt of urine; tho' at length it diſſolved a large proportion of it. And tho' ſtrong oil of vitriol being put upon ſome of the forementioned cryſtals, did readily work upon them, and in corroding them, excited numerous bubbles; yet this did not make me conclude the ſalt to be alkaline; becauſe I have obſerved oil of vitriol, tho' not ſpirit of ſalt, or *Aqua fortis*, to work, after the like manner, upon common ſalt, whereof that the fixed ſalt of urine partook, ſeems probable from the phenomenon juſt mention'd; becauſe by impregnating good *Aqua fortis*, with a competent quantity of this fixed ſalt, inſtead of ſea ſalt, I could make it corrode foliated gold, even without heat; becauſe ſome part of the ſolution of our fixed ſalt, that was more ſlowly coagulable, being mix'd with oil of tartar, preſently grew thick and muddy, and ſoon after let fall a large precipitate; and, laſtly, becauſe another part of the ſame ſolution did readily precipitate ſilver diſſolved in *Aqua fortis*, but would not diſcolour a ſtrong ſolution of ſublimate made in fair water; from which a common lixiviate alkali would have immediately ſtruck down an orange colour'd powder.

A ſuſpicion I once had, that the common ſalt, uſed to ſeaſon our aliment, might, in ſome degree, impregnate our urine, occaſioned me to examine that of horſes; which I found to require rather a ſhorter putrefaction than human urine, to fit it for diſtillation. By the ſpirit and volatile ſalt of this fluid, which are eaſily obtain'd, it ſeem'd probable, that the fixed ſalt would have been not unlike that of human urine; tho' I had not an opportunity to examine the *Caput mortuum*. I here choſe to inſtance in urine, becauſe chymiſts never extract the fixed ſalt thereof; tho' all the parts of that fluid ſeem applicable to very good purpoſes.

SECT. II.

Different kinds of ſpirits, producible. THE chymiſts apply the name ſpirit to ſo many different ſubſtances, that ſuch an ambiguous uſe of the word ſeems to ſhew, they have no clear and ſettled notion of the thing. Moſt of them, indeed, in the general, give the term ſpirit to any diſtill'd volatile liquor, that is not inſipid, as phlegm, or inflammable as oil. But under this general idea, they comprehend liquors that are not only of a different, but, according to their principles, of a quite contrary nature; ſome of them being acid, as ſpirit of nitre, of ſalt, and of vinegar; and others urinous, or volatile alkalies; which are ſuch enemies to the former, that as ſoon as they are put together in due proportion, they tumultuate and grow hot; and uſually continue thus, till they have diſarmed or mortified each other. Beſides the two hoſtile families of ſpirits, there is a third, called by them vinous, or inflammable; which, tho' very ſubtile and piercing, is not manifeſtly either acid or alkaline; for the taſt and ſmell of this ſpecies, is different from both the other ſorts; and yet it is referr'd to one or the other of them, by ſome learned chymiſts; with whom I need not diſpute about this matter, ſince 'tis ſufficient for my deſign, if it can be made out, that all the three ſorts of ſpirits, the vinous or inflammable, the urinous or alkaline, and the acid, may be produced.

The vinous. And to begin with the vinous ſpirits. Theſe are ſo producible by art, that we ſeldom find them produced by nature alone, which, indeed, makes the juice of grapes, but not wine, nor the ſpirit of it; unleſs, by the help of man, that juice be preſs'd out and fermented. And the caſe is yet more plain in the inflammable ſpirits of ale, beer, and in the like, made by boiling and fermenting the ſeeds, and other parts of vegetables. And 'tis obſervable, that muſt does not, in diſtillation, yield a vinous and inflammable ſpirit. I had once the pleaſure to laugh at a man, otherwiſe very ingenious, who, to catch the ſubtile vinous ſpirit, that he would have me think was loſt in the common way of treating wort, cauſed it to work in a copper limbec; by which means he obtained nothing but a nauſeous phlegm. I have, alſo, found by trial, that raiſins diſtill'd alone, afford an acid and empyreumatical, but not a vinous ſpirit; tho' when I carefully fermented them in a due proportion of water, they would yield, in diſtillation, an inflammable ſpirit, like that of wine.

If it be objected, that the vinous and inflammable ſpirit, obtained from bodies by fermentation, was actually in them before, and is only extricated by fermentation; I anſwer, that this is *gratis dictum*, and not to be admitted without proof; ſince raiſins, and ſuch other fermentable bodies, do not, upon the ſuppoſed analyſis, made by diſtillation, afford a vinous ſpirit, but one very different from it. And I ſee not why the change of texture, may not turn ſome part of the juice of grapes into a vinous and inflammable liquor; ſince a little further change is able to turn the ſame juice into an acid liquor, that is neither vinous nor inflammable, as it was before. And I have found by trial, that even this vinegar, crude as it is, being ſatiated with the calx of lead, made *per ſe*, would afford a ſpirit not acid, but of a very different taſt, and inflammable, like the ſpirituous parts of wine. And if it ſhould be further objected, that theſe inflammable ſpirits were not produced by ſuch operations, but, pre-exiſting in the newly expreſs'd juice of grapes, were only extricated by fermentation; and, being afterwards diſguized by the acid particles of the vinegar, were again extricated by diſtillation; the acid ſalts having fix'd themſelves upon the lead they corroded, and thereby given the ſpirits leave to forſake them; I might obſerve, that the objection alledges no phenomena, to make the actual pre-exiſtence of vinous ſpirits appear, either in the juice of grapes, or in the ſolution of lead. But to examine this matter further, I made a *Saccharum Saturni* with an acid liquor, obtained without fermentation, or the addition of any fluid, from wood it ſelf; and then diſtilling it, alſo, *per ſe*, I had a ſpirit that readily took fire, and burnt away in a blue flame, like that of ſpirit of wine. I know another objection may be framed from the doctrine of ſome chymiſts, who would have ſpirit of wine to conſiſt of the oily parts of the juice of grapes rarified and ſubtilized. But I need not enter into a diſpute with theſe learned men, ſince, without examining whether their opinion be true or falſe, if it be admitted, it will be conſiſtent enough with mine. For to ſay, that by ſubtilization, rarifaction, a peculiar kind of commixture with the phlegm, or the like means, the oil contain'd in the juice of grapes becomes ſpirit of wine; is but to aſſign the *modus*, whereby vinous ſpirits are produced, not to deny their production. And all I require is, to have it proved, or granted, that inflammable ſpirits are really produced, by what way ſoever it be. I ſhall add, tho' experience ſhews, that honey, being skilfully fermented with a due proportion of water, will yield a greater quantity of inflammable ſpirit, than the wine that is made in ſeveral countries; yet when we carefully diſtill'd honey, as before fermentation, it afforded us a great proportion of a conſiderably acid ſpirit, that would diſſolve ſome metals; but a ſurprizingly ſmall quantity of oil: whence 'tis unlikely that ſo inconſiderable a proportion of that liquor, ſhould be rarifiable into ſo much inflammable ſpirit, as may be obtained from well fermented honey.

The urinous I proceed to the other ſort of ſpirits, as thoſe of hartſhorn, blood, ſal-armoniac, ſoot, *&c.* which we formerly call'd urinous, becauſe of their great affinity, in many qualities, to ſpirit of urine. But as for theſe, I know not whether it will be neceſſary to treat of their origin apart, ſince they ſeem not ſimple, but compound bodies, conſiſting of the volatile ſalt of the reſpective concretes, diſſolv'd in the phlegm; and, for the moſt part, accompanied with ſome little oil, at firſt undiſcerned by the eye, tho' it afterwards becomes viſible. The preſence of this oil in moſt ſpirits belonging to this family, may, probably, be argued from the deep tincture, that, in tract of time, the ſpirits of hartſhorn, of blood, &c. acquire by ſtanding; tho' preſently after their diſtillation, and firſt or ſecond rectification, they were clear and colourleſs as water. But in ſpirit, drawn, by the help of an alkali, from ſal-armoniac, a concrete not abounding in oily parts, like hartſhorn, blood, &c. and kept for ſeveral years, I obſerved no ſuch diſcolouration. Having, therefore, hitherto, by rectifications and digeſtions, found nothing in theſe urinous ſpirits but a cryſtalline, volatile ſalt, moſt commonly ſeparable in a dry form, and the phlegm it was diſſolved in, beſides ſome oleaginous particles that had aſſociated themſelves to it; 'twere unneceſſary to alledge particular inſtances as to this ſort of ſpirituous liquors: 'tis ſufficient to refer them to our conſiderations on the production of volatile ſalts.

And the acid.

That ſome acid ſpirits may be generated, or produced, *de novo*, muſt ſeem probable from what has been already deliver'd as to the production of acid ſalts; and from what we ſhall ſay of acid, urinous, and volatile ſpirits, obtained by diſtillation from the ſame body. And if we take the word acid, as I here uſually do, in a familiar ſenſe, without nicely diſtinguiſhing it from thoſe ſapors that are of kin thereto; perhaps the ſpirit of ſea-ſalt, and that of nitre, may be proper inſtances of the production of acid ſpirits. For tho' ſea-ſalt, and its diſtilled liquor, have, upon ſome bodies, the like operations, as either of them will precipitate ſilver out of *Aqua fortis*, yet the taſt of the ſpirit of ſalt is exceedingly different from that of crude ſalt, not only in ſtrength and penetrancy, but in being highly acid; whereas the crude ſalt has a taſt not properly acid, but that which by a diſtinct name is called ſaline, ſuch as predominates in brine: and it does not appear that this acid ſpirit pre-exiſted in that ſtate, in the ſalt whence it was obtained; ſo that we may ſuppoſe it to have been made rather by tranſmutation than extrication. And the like, I think, may, with greater probability, be ſaid of the ſpirit of nitre; for tho' this be highly acid, yet the nitre that afforded it, is not at all ſenſibly acid: and this new vehement taſt of the ſpirituous parts, as well as their great efficacy in diſſolving metals, and other bodies, ſeems to have been produced by the violent action of the fire, which, by ſplitting the nitrous corpuſcles, or by rubbing them one againſt another, &c. makes a comminution of them into fragments, or particles; which, both, becauſe of their ſmallneſs and lightneſs, may be elevated by the action of the fire; and becauſe of the ſame minuteneſs, and their ſharp pointed figures, may get into the pores of many other bodies, and divide their parts. Chymiſts, indeed, may object, that all the acid ſpirit, which can be diſtill'd from nitre, was really pre-exiſtent, and only clogg'd and diſguiz'd by the alkaline ingredient, wherewith it was aſſociated; as may appear, by what I related, of the quick way of making ſalt-petre, by putting a due proportion of the ſpirit of nitre to the alkali, or fix'd part that remains after the ſalt-petre has been fulminated. This proves, indeed, what I readily grant, that ſalt-petre may be artificially compounded of a nitrous ſpirit, and a fix'd alkali; but does not prove, that nature always, or ordinarily, produces nitre, by compounding it of the ſame ingredients: for, it does not appear, that wherever ſalt-petre is generated in the earth, nature has, beforehand, laid in a proviſion of lixiviate ſalt, that is not, with us, to be made, without the violence of an incinerating fire, and of corroſive ſpirits; to obtain which, or either of them, vehement fires are employ'd; whilſt ſalt-petre ſeems to be ſlowly generated in the earth, by gradual, or ſucceſſive alterations of ſome proper matter; wherein, for ought I have obſerv'd, not an acid, but an urinous ſalt is predominant; ſince earth, that had long lain cover'd with pigeons dung, in a dove-houſe, yielded a volatile ſpirit and ſalt like thoſe of urine, in diſtillation. I will not, therefore, affirm, that nature never employs fix'd alkalies, and acid ſpirits, to make ſalt-petre; yet, I ſee not that chymiſts have hitherto offer'd any cogent proof, that ſhe muſt neceſſarily do ſo. I farther obſerve, that, according to what was formerly noted, ſalt-petre, diſtill'd in cloſe veſſels, affords but an inconſiderable quantity of fix'd ſalt; and that too, a very imperfect alkali; tho' the quantity of nitrous ſpirits was great enough to perſuade us, that nothing near ſo much as was wanting of the entire weight of the ſalt-petre, had paſs'd into the receiver. And a friend of mine, by the help of a peculiar clay, obtain'd near a pound of ſpirit of nitre, from a pound of ſalt-petre; whilſt, on the other ſide, by a different management, tho' without addition, I obtain'd about ten ounces of fix'd nitre from a pound of ſalt-petre: whence, it ſeems probable, that the ſame ſubſtance, which, in crude nitre, is almoſt inſipid, may, by an operation of the fire, be diſtill'd into a highly acid ſpirit, as well as, by another operation and way of management, be brought to the nature of a fix'd and cauſtic alkali. It may, alſo, be worth conſidering, whether the perfect ſpirit of nitre may not be depriv'd of its acid nature, and become, or, at leaſt, materially concur, to make up a fix'd alkali. For, if ſea-ſalt, which chymiſts do not pretend contains any ſuch alkali, be throughly diſſolv'd in a ſufficient quantity of ſpirit of nitre, the ſalt, thus compounded, will yield a conſiderable proportion of fix'd alkali, reſembling that of ſalt-petre; which is as likely to proceed from the nitrous, as from the marine part of the reſulting ſalt: and if ſo, 'tis the more probable, that the ſaline corpuſcles of ſpirit of nitre, are not primordial bodies, ſince they may be deſtroy'd, or turn'd into other ſalts: which is not leſs repugnant to the nature of a principle, than 'tis to be, *de novo*, producible from a body that was not acid before.

It may add much probability, to what was above ſaid, concerning the producibleneſs of the different ſorts of ſpirits, if it ſhall appear, that

The ſame body may, by being differently treated, afford five kinds of ſpirits.

that the ſame body, merely by different ways of ordering it, may be eaſily brought to afford either acid, inflammable, or volatile ſpirits, as the artiſt pleaſes.

An inſtance of this, we may have from ſome kinds of pulſe, as beans, *&c.* which, if newly gather'd, and diſtill'd in a retort, afford, beſides a great deal of phlegm, an acid ſpirit. And I had ſuch a ſpirit from either peaſe, or beans, or both, after they had been kept till they loſt their verdure. But if theſe ſeeds be, at a fit time duly fermented with common water, it will not be doubted, but that they, as well as other mealy ſeeds, muſt yield an ardent ſpirit: but, it will not be eaſily believ'd, that without adding any thing to them, and barely by keeping them in a dry place, for a certain number of months, they will yield a ſpirit, that by one, who did not know whence it proceeded, would be judg'd near a-kin to that of urine, or of hartſhorn, and to other ſaline liquors, drawn from animal ſubſtances; yet, having diſtill'd theſe pulſe, by themſelves, and without ſo much as bruiſing them, they afforded ſpirits, not only far more like in ſcent to thoſe I juſt enumerated, than they were either to acid or vinous ſpirits, but allied to them in more intimate qualities; ſince they would, as the ſpirit of urine and hartſhorn, make a conflict with acid ſpirits, turn ſyrup of violets green, diſſolve copper blue, precipitate a ſolution of ſublimate into a white ſubſtance, and give the other diſtinguiſhing marks of volatile and urinous ſalts and ſpirits.

Vegetables, alſo, may eaſily, by a dextrous ſublimation, be brought to exhibit many of their nobler parts in the form of a dry ſalt, as well as in that of a ſpirituous liquor.

The freſh juice of grapes, or muſt, tho' ſweet in taſt, will, if it be timely diſtill'd to the conſiſtence almoſt of a ſyrup, yield a great quantity of phlegm, but no ardent ſpirit; and if the ſuperfluous moiſture be ſkilfully evaporated, there will remain a kind of ſapa, of a pleaſant tartneſs, which I have known uſed in ſome places, as an excellent ingredient in ſauces, and alſo to ſpread upon bread, inſtead of butter.

An acid and a vinous ſpirit from the juice of grapes.

But if this ſapa were preſently diſtill'd, I ſuppoſe it would yield no vinous, but an acid ſpirit; tho' for want of vineyards in *England*, I could not examine any liquor taken out of great veſſels of muſt, and therefore cannot ſay, preciſely and experimentally, what diſtill'd liquors it wou'd afford; ſince I know not, certainly, whether the large quantity of the ſweet liquor, and its continuance for ſome time in the ſtate of what they call muſt, may not ſomewhat alter its productions: but if, as it is probable, that diverſity be not conſiderable, I may ſafely ſuppoſe the vinous ſpirit, afforded by the juice of grapes, after fermentation has turn'd it into wine, is a produced thing, and was not in that form pre-exiſtent in the juice; for having purpoſely cauſed ripe grapes to be moderately preſs'd, that the juice might, without much dreggy matter, be ſqueezed out; we put this liquor into a glaſs head and body, and, diſtilling it with a gentle fire, obtained a ſcarce credible proportion of phlegm; and then transferring the inſpiſſated remainder into a retort, after having kept ſome of it for ſapa, we proſecuted the diſtillations with a ſtronger fire, and obtained not a vinous, but an acid ſpirit; as we found by its ſmell and taſt; by its corroding fragments of coral, even in the cold; by its growing ſweet upon minium, *&c.* Agreeable to this experiment I found, by tryal, that raiſins, which conſiſt chiefly of the juice of grapes inſpiſſated in their skins, by the avolation of the ſuperfluous moiſture thro' their pores, being diſtill'd in a retort, did not afford any vinous, but rather an acetous ſpirit, that as an acid liquor wou'd work upon ſeveral bodies like ſpirit of vinegar; and yet, as was formerly noted, 'tis known that raiſins, being fermented with a due proportion of common water, will, after a certain time, afford a vinous and inebriating liquor. And tho' in the better ſort of the known ways of making artificial wines, many months, are uſually ſpent in the preparation; yet I have practiſed a method which conſiſts chiefly in a determinate proportion of the water to the raiſins, by the help of which, the liquor, in very few weeks, became fit to drink; and conſequently to afford, by diſtillation, a vinous ſpirit.

An acid ſpirit of wine.

Nay, from the juice of grapes, even after it has been duly fermented, there may be obtain'd by diſtillation, a liquor, which, having not found mention'd in authors, I take the liberty to name, upon account of its taſt, and ſome other qualities, acid ſpirit of wine. And I choſe to make the experiment with canary, as a wine fully ripe, and remote from an acid and tartarous nature. We took, then, ſome good canary, and having with digeſtive-furnace, and in a glaſs head and body, ſlowly drawn off the ardent ſpirit firſt, and then the phlegm, till there remain'd a liquor of the conſiſtence of a thin ſyrup, we remov'd it into a retort, and diſtill'd it by degrees of fire; whereby we obtained, beſides a ſouriſh phlegm, that came firſt over, a true acid ſpirit; as appeared, not only by the taſt, but by the hiſſing noiſe and numerous bubbles that were produced, when we poured it upon a lixiviate ſalt; as alſo by this, that having put it upon powdered corals, it began briskly to diſſolve them, even in the cold: we likewiſe made it corrode ſome metalline and mineral bodies. As this acid ſpirit of wine has a different origin from that of other known acid ſpirits, and even from ſpirit of vinegar, I thought it probable, that it might have ſome peculiar qualities; and having put ſome of it upon filings of copper, in ſuch manner, that part of them being firſt moiſtened therewith, ſhou'd remain expos'd to the air; and others lie beneath the liquor; I found, tho' the tryals were made in the cold, that, in a day or two, the expoſed filings had gained a fine bluiſh green colour; but the ſpirit that ſwam upon the other, in few hours, acquired a fine redneſs, which afterwards, in two or three days, degenerated into a co-

colour like that of the expoſed filings. The *Caput mortuum* of the diſtill'd wine I found a more fix'd body than one wou'd have expected: and tho' probably the finer part belonging to the juice of grapes, being attenuated and ſubtiliz'd, was changed into an ardent ſpirit, and therefore appeared not in the diſtillation in the form of oil; yet 'tis not unlikely, that the courſer part of the oleaginous ſubſtance remained ſtill in the *Caput mortuum*; for holding it in the flame of a candle, I obſerv'd, that it wou'd partly exhale in thick ſmoke, partly melt, and as it were fry, and partly burn with an actual flame, which was not only continued while that of the candle cheriſh'd it, but wou'd, after it was removed from thence, continue to flame for a conſiderable time: and a parcel of it being caſt upon quick coals, burned with a blaze, almoſt as if it had been amber or bitumen.

A volatile or urinous ſpirit from the juice of grapes.

To return to our juice of grapes; we ſee, merely, by a ſlight difference, in point of management, it may be made to afford either a vinous or acid ſpirit: and I ſhall now add, that it may be brought to yield a volatile or urinous one; for 'tis known, that, in proceſs of time, wine affords tartar; and tho' chymiſts ſuppoſe the ſpirit of tartar to be of a quite different nature from that of urine and of ſoot; and tho' tartar diſtill'd in the common way, affords an acid ſpirit, and another that I call anonymous; yet, by a peculiar and ſlow way of operating, I have been able to obtain from crude tartar, without any addition, a ſpirituous ſubſtance, that in taſt, ſmell, and ſeveral manifeſt operations, much more reſembled the volatile ſpirit of ſoot, obtain'd as mine of tartar was, by mere diſtillation, than an acid ſpirit; with which it was diſpoſed to make a conflict as ſoon as they were put together. But ſuch a kind of volatile ſubſtance may be, far more eaſily, obtain'd from the lees of wine, than from tartar; for having been informed, that an expert chymiſt, in *Germany*, had found the way to get much volatile ſalt from lees of wine, I reſolv'd to try whether it might not be done without any addition; and having procured ſome of the beſt lees of *Rheniſh* wine, I caus'd them to be expoſed in broad veſſels to the ſun, and the free air, that they might leiſurely dry, if not alſo be impregnated, in order to the volatility of their ſaline parts. Then theſe dry'd feces being carefully diſtill'd in a retort, by degrees of fire, the liquor was ſlowly rectified; by which means there aſcended, before the phlegm, a ſpirituous part, which wou'd turn ſyrup of violets green, precipitate diſſolv'd ſublimate into a white powder, ſoon colour it ſelf upon copper with a deep blue, *&c.* from whence we may infer, that the ſame matter, as it is differently managed, may be made to afford an acid, and one we call anonymous, an acetous, a vinous, and a volatile ſpirit.

Obſervations upon a new anonymous ſpirit.

And here I will relate ſome of the more expeditious and eaſy tryals that I have made about that kind of liquors, which I ſtyled anonymous; becauſe when I firſt ſeparated them from the acid ſpirits, wherewith chymiſts had before confounded them, their properties were very little known to me; but having ſince found them to differ in ſeveral qualities from vinous, from acid, and from urinous ſpirits; and having not ſufficiently diſcover'd their poſitive properties, I call each the neutral, or adiaphorous ſpirit of the body that affords it.*

But 'tis here proper to premiſe a few things in the general. 1. Our adiaphorous ſpirit may be obtained, by diſtilling the liquor afforded by woods, and ſeveral other bodies, from coral, or calcined lead; for by this means the acid corpuſcles of the menſtruum will work upon the coral, or the lead, and ſo faſten themſelves to what they corrode, as eaſily to part with the adiaphorous ſpirits, which are thus permitted to aſcend, by themſelves, and fall into the receiver in the form of a liquor. I endeavoured to try, whether there was any difference in gravity or fixedneſs, between the acid and neutral ſpirit of wood, without mortifying the former; and whether, by the help of this gravity and fixedneſs, I could ſeparate the acid from the other, and ſo preſerve it diſtinct.

In order to this, I cauſed a quantity of the rectified ſpirit of box, to be ſlowly diſtill'd in a glaſs body and head, placed in ſand, with the flame of a lamp; and in the firſt 24 hours, obtain'd but about two ſpoonfuls of liquor; and tho' the menſtruum firſt put in, ſcarce exceeded a pound, yet it was ſeveral days and nights in drawing over. And in the operation, the liquor that firſt aſcended was not phlegm, but had a very piercing taſt; yet without any manifeſt acidity diſcoverable by the tongue, tho' by putting it upon fine powder of coral, it had ſome operation, that made me think it not wholly void of acid particles. And having often ſhifted the receiver, the better to judge whether the portions of the aſcending ſpirit were conſiderably different in quantity, I found the liquor that came over towards the latter end, ſharper than before: and having, at length, diſtilled all I could make riſe, we found the laſt parcel to be of a good yellow colour, tho' thoſe that preceded it were limpid; and this was in ſcent ſtrong of vinegar, and to taſt more acid than ſpirit of common vinegar; ſo that had I not known how it was obtained, I ſhould have ſuſpected it to be *Acetum radicatum*; and, accordingly, I found it to be a very active menſtruum in the diſſolution of ſome bodies, that, for trial ſake, were put into it. Now all this ſeems to argue, that the acid portion of ſuch diſtilled liquors, is more ponderous, or more fixed, than the adiaphorous ſpirit, which, upon that account, may be, in great part, ſeparated from it by bare diſtillation, if carefully performed.

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* 'Tis obſerved by M. *Homberg*, that towards the concluſion of the analyſis of a plant, unfermented, there uſually comes over a certain liquor, which appears to be both an alkali, and an acid; for it makes a ſtrong ebullition with ſpirit of ſalt, and changes the tincture of turnſol red. To examine into this phenomenon, he ſeparately diſtilled two plants, the one abounding in volatile ſalt, the other in acid; and rectifying the acid of the one, till it reſembled diſtilled vinegar; and purifying the ſalt of the other, he plentifully diſſolved of this ſalt in its urinous ſpirit. Then mixing the two together, no ebullition enſued; tho' they would both, apart, make a very great effervеſcence, the one with ſpirit of ſalt, and the other with oil of tartar: and long continuing thus quietly together, he had a deſire to ſeparate them by diſtillation; but a very gentle heat firſt raiſed a liquor lightly urinous, and at length there aſcended a white, cryſtalline, ſaline ſalt, that yielded ſomething of an urinous ſcent. This increaſed his wonder; for ſuch a volatile ſalt from plants he thought a new thing in chymiſtry. This ingenious gentleman, afterwards poured about ſix parts of diſtilled vinegar, upon one of ſpirit of urine, well ſaturated with ſalt, and no efferveſcence, nor ebullition enſued: and theſe were diſtill'd in the ſame manner, with the ſame effect as the former. Hence M. *Homberg* concludes, that there is a certain proportion of force required to make an acid work upon an alkali. For, in theſe caſes, the acid is on one ſide too weak, and the alkali too ſtrong. A vegetable acid, he ſays, is a *Sal terræ*, attracted by the plant, ground, broke to pieces, and weaken'd in the circulations and fermentations it undergoes therein; but, that a ſtrong ſpirit of urine, well impregnated with volatile ſalt, muſt be full of ſolid, maſſy parts, which lying cloſe by one another, are not to be ſeparated by a ſmall force. And, accordingly, a mineral acid, which has never been weakned like the other, eagerly falls upon that ſpirit of urine, and ſo will the vegetable acid too, if the urinous ſpirit be ſufficiently diluted and weaken'd with phlegm. See *Memoir. de l'Acad.* A. 1701. *p.* 288.

2. I have obſerved theſe neutral ſpirits to be not, all of them, in every reſpect, of the ſame nature; for tho' they agree in ſome general properties, which entitle them to the ſame ſpecies or denomination, yet they ſometimes differ from one another in particular qualities. It muſt not, therefore, be thought ſtrange, if ſome of the experiments I ſhall ſet down, do not punctually ſucceed in their hands, who ſhall not make uſe of the anonymous ſpirit of box, which I employed; for when I ſpeak of an adiaphorous ſpirit in general, I mean the ſpirit of box; which I had freed from its acid part, by diſtilling it from calcined coral.

3. Tho' the few chymiſts, who have taken notice of the diſtilled liquors of woods, for example, look upon them, by reaſon of their acid taſts, as meerly acetous, and accordingly call them the vinegars, or acetous ſpirits of wood; yet, really, the acid portion of theſe diſtilled liquors, is far from being the greateſt. For, beſides what other trials I have made to ſhew this, I took eight ounces of the rectified ſpirit of box, wherein the acetous and neutral ſpirit remained confounded, as they had been in the firſt diſtillation; and having poured this upon a quantity of calcined coral, ſufficient to ſatiate the acid corpuſcles, which quickly fell to corrode it with noiſe and bubbles, we gently diſtill'd it, to a dryneſs, in a glaſs head and body; by which means we obtained of adiaphorous ſpirit very near ſeven ounces and a half: and ſome of the menſtruum being waſted in the operation, the acid corpuſcles remaining in the bottom with the coral they had corroded, weighed but between two and three drams; which ſhews, that notwithſtanding the conſiderable quantity of ſtrong ſpirit of vinegar, that the diſtill'd liquor of box contains, the corpuſcles that make it ſo acid being concentred, take up but little ſpace. And as it was rational to ſuſpect, that the acetous corpuſcles, being made without fermentation, might have ſomething peculiar in their nature, I cauſed

them to be gradually diſtill'd, with a ſtrong fire, from the coral; and thereby obtain'd a very red ſpirit, which, tho' many chymiſts wou'd take it for a volatile tincture of coral, was of a very ſtrong ſcent, and a taſt exceeding piercing, but very different from that of acid liquors.

Chymiſtry.

Whether our adiaphorous ſpirit may be generated by the commixture of the finer parts of the oil of the wood, reduc'd to an extraordinary minuteneſs, and thereby render'd fit to be exquiſitely mix'd with the phlegm, and ſtrictly aſſociated with its particles, I ſhall not, till I am better furniſhed with experiments, venture to determine.

Having premis'd theſe general obſervations, I ſhall proceed to particulars; but deſire it may firſt be noted, that for the better diſcerning the phenomena to be produced, I made almoſt all the following experiments in cylindrical glaſſes, about an inch in diameter.

(1.) Having into our adiaphorous ſpirit of box, drop'd a convenient quantity of ſtrong tranſparent oil of vitriol, and ſhaken the liquors together, there preſently emerg'd a rich and lovely red colour, which, at firſt, was diaphanous, but afterwards grew ſo deep as to be opake; tho' by ſhaking the glaſs, the thin liquor that wou'd ſlowly glide down the inſide of it, being held againſt the light, manifeſted the colour to be ſtill red, but much more dark than before.

(2.) Some common *Aqua fortis* being put to our neutral ſpirit, and ſhaken a little with it, preſently gave it a rich amber colour, but not a true red; but if the liquors were not mingled by agitation, the ſpirit ſlowly and gradually obtained the ſame colour: after this change, the ſpirit continued tranſparent; and, which ought not to be omitted, the change, at firſt, was wrought without any manifeſt precipitation, tho' afterwards, when the mixture had reſted a good while, there appeared ſome little and light feculency at the bottom of the glaſs; and the inſide of it, as far as the liquor reach'd, was ſullied with a cloudineſs not eaſy to be waſhed off. One circumſtance more of this tryal too, I muſt not omit; that notwithſtanding the ſtrong and offenſive ſmell, uſual in *Aqua fortis*; it had in our mixture either none, or a very faint one; being conceal'd, ſuppreſs'd, or diſguized by the predominant odour of the adiaphorous ſpirit.

(3.) Some ſpirit of ſalt being added to our ſpirit of box, the mixture became much leſs tranſparent than the liquors before their conjunction, and for a day or two, was only whitiſh; but when we remov'd it into a digeſtive furnace, and kept it there for many hours, it acquir'd a high colour, partaking of brown and yellow; and appeared to have let fall ſome little ſediment.

(4.) Having put ſome of our adiaphorous liquor on ſalt of tartar, it had not any ſenſible operation upon it, except that it diſſolv'd the ſalt, and, after ſome digeſtion, appeared of a yellow colour, tending to brown, and faſten'd to the inſide of the vial in many little grains of ſalt, Chymiſtry. ſalt, that ſeemed to have been firſt diſſolv'd, and then coagulated again in new figures.

(5.) Our adiaphorous liquor being confounded with highly rectified ſpirit of wine, neither of them appeared, conſiderably, to change their colour; there only appeared a ſmall tendency to a yellow, or to grow opake by their conjunction, even after ſome days digeſting; but the vinous ſpirit did not hinder the other from turning red, by the action of ſome ſtrong acid, when poured on the mixture.

(6.) Rectified ſpirit of urine, put to our adiaphorous liquor, did not make any conflict, but joined quietly, with it, or manifeſtly change the colour of either, whilſt they were kept many hours in the cold; but being transferr'd into a digeſtive furnace, and there detain'd for a night or two, the liquor acquir'd a high colour, which was almoſt orange-brown; and there appeared ſome little feces at the bottom. Having made theſe tryals upon our ſpirit with ſimple liquors, I thought fit to make ſome with ſuch compounded ones, as the ſolution of metals; to ſee, tho' it were neither, manifeſtly, of an acid, an urinous, or a lixiviate nature, if it wou'd precipitate any part of the diſſolved metals.

(7.) To proſecute this inquiry, I drop'd into ſome of our ſpirit, a little ſolution of refined gold, which, at firſt, imparted its own colour thereto; but the mixture quickly loſt its tranſparency, and grew muddy, and, after a while, let fall a conſiderable quantity of ſediment, or precipitate; the upper liquor having acquired a browniſh colour.

(8.) Having mix'd our ſpirit with a good ſolution of crude lead, made with an appropriated menſtruum, that diſſolves it readily, and clear, almoſt as *Aqua fortis* does common ſilver; the mixture preſently became muddy, and after ſome days let fall a large ſediment, over which ſwam a liquor between brown and red.

(9.) We put to our ſpirit of box, ſome fine blue ſolution of copper, made with an urinous ſpirit; and ſoon perceiv'd the mixture to grow turbid, which afforded us, tho' but very ſlowly, a plentiful reſidence.

(10.) We mixed with the ſame ſpirit a convenient quantity of ſtrong infuſion of ſublimate, made in fair water; but found not any manifeſt action between thoſe liquors, no more than between dry and undiſſolved ſublimate, and the ſame ſpirit, when we kept them together, in this ſame vial.

(11.) Mixing our ſpirit with oil of tartar *per deliquium*, there did not, ſuddenly, appear any manifeſt change; but having digeſted the mixture for ſeveral days, there precipitated a light feculency, whilſt the upper liquor, which was tranſparent, appear'd of a colour inclinable to red.

(12.) We, alſo, mingled with ſome of it a convenient quantity of vitriol of copper, diſſolv'd in fair water, till the liquor ſeem'd ſatiated

ted with the vitriol; but I remember not that, in ſeveral days, the ſolution grew manifeſtly opake or diſcolour'd.

(13.) We put to our ſpirit a ſolution of tin, made in a menſtruum that diſſolves it clear; but very little alteration enſued, tho' we left the liquors for many hours together.

(14.) But, when I put to our ſpirit a convenient quantity of the ſolution of mercury, made in *Aqua fortis*, the colour of the mixture became firſt deeply yellow; and, in a minute or two, intenſely red; and being digeſted for ſome days, I found, at the bottom of the vial, a white precipitate, much larger than I expected; and the tranſparent liquor that ſwam above it, was of a rich golden colour. Whether phyſicians or ſurgeons ſhou'd apply this precipitate, or tinged liquor, to medicinal purpoſes, I ſhall leave them to conſider.

(15.) Several of the foregoing experiments were try'd with the ſpirits of other woods, beſides box, and in particular, with thoſe of oak and guaiacum; the phenomena whereof were not, always, the ſame with thoſe above recited; which may, probably, argue ſome difference in the nature of ſuch ſpirits, as there is in the conſtitution of the woods that afforded them.

(16.) Having put of our neutral ſpirit upon ſome pieces of fine red coral, and kept them together for many days, the liquor did not appear to have extracted any tincture from them; tho' the upper part of the higheſt fragments ſeem'd to be turned white.

(17.) And, laſtly, taking a parcel of this ſpirit, that came over by rectification, in a lamp-furnace, long before the more fixed acetous ſpirit aſcended, I expoſed a vial, ſcarce half full of it, in a very ſharp froſty night, in a garden covered with ſnow and ice; but it was taken up, the next morning, not at all frozen, tho' leſs limpid than before; and thus it continued, either in a greater or leſs degree, for ſome weeks after.

SECT. III.

That ſulphurs are producible.

THE ſubſtances which chymiſts call the ſulphurs of the mixed bodies, that, by the help of the fire afford them, are not of ſo uniform a nature as might be expected in the portions of the ſame principle. For, as on the one hand, they make inflammability the conſtituent character of ſulphur; ſo on the other, 'tis obvious, that there are, at leaſt, three ſubſtances, manifeſtly different in conſiſtence, texture, or both, which, according to that notion, ought to be referr'd to ſulphur. For ſometimes the inflammable ſubſtance, obtained from a mixed body, by means of fire, appears in the form of an oil, that will not mix with water; ſometimes in the

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'Tis not, however, impoſſible, that in moſt mix'd bodies, what is called ſulphur, may be no primordial ingredient, but rather a generated or reſulting thing. For what is common to theſe different bodies, which paſs under the name of ſulphurs, and is the eſſential quality that diſcriminates them from the other material principles of mixed bodies, muſt be confeſs'd, if we will ſpeak intelligibly, to be a diſpoſition to be turn'd into fire, and uſually, alſo, into flame. But ſulphur, it ſelf, is made of the ſame univerſal matter whereof other bodies conſiſt, and is only a coalition of certain particles thereof; whoſe aggregate, by having a particular texture, motion, *&c.* acquires thoſe properties, on whoſe account it is called ſulphur. And, therefore, if the like texture be found in other portions of matter; or if art and chance can frame, and bring together particles of matter, and give them ſuch a texture, as diſpoſes them to be kindled, and flame, or burn away; theſe qualifications of ſuch an aggregate of corpuſcles, entitle it to the nature of a ſulphur; whether this portion of matter conſiſt, or largely participate of the chymiſts primeval ſulphur or no. For, it is not by virtue of the long duration of a thing, but by the eſſential qualities belonging to it, that a body deſerves its denomination. Thus, the ſnow that fell yeſterday, and was generated inſtantly, is as true ſnow, as that which has lain for many years on the *Alps.* And, in the judgment of the chymiſts themſelves, a pound of quick-ſilver newly tranſmuted, by a grain or two of their elixir, into gold, becomes as true gold as that which was coeval with the moſt ancient mines of that metal.

Shewn in oils. That 'tis not neceſſary the oil or ſulphur, obtained, by the fire, from mixed bodies, ſhould be a primeval element, or principle, may be probably argued from the growth of plants, fed merely by water; which nevertheleſs afford an oil in diſtillation. And, we ſee, that in almond trees, walnut trees, *&c.* the rain water, which inſinuates it ſelf into their roots, is, by ſucceſſive changes of texture, reduced into the oil, which the fruit, by expreſſion, ſo plentifully affords. And, to obviate the ſuſpicion, of common waters being impregnated with the groſſer juices of the earth, I employ'd diſtill'd water to nouriſh a plant.

A ſprig of mint, put into rain water diſtill'd, and fed, almoſt wholly, with re-diſtilled rain water, weighed, at firſt, three grains; and being taken out when it had grown leſs than a month, weigh'd, after it was well dry'd with paper and a cloth, ten grains and about a quarter. Another ſprig, put in and taken out at the ſame time with the former, had attain'd to near four times its firſt weight; and ſhot out a ſecond ſprig much higher than the firſt, and many roots, ſome of them near as long again as the whole plant when it was firſt put in.

If we conſider what a great quantity of oil is afforded by an olive yard, whoſe trees are, probably, nouriſhed chiefly by rain water, that, being imbibed by the roots, is by various digeſtions, or preparatory changes, turned into oil; it will appear probable, that oil may be produced of other ſubſtances; ſince in our inſtance it ſeems to have been made by a tranſmutation of water; tho' this be generally reputed of all liquors the moſt contrary to, and is evidently of a nature exceeding diſtant from it.

And here I will relate an experiment, by which I attempted to produce oil out of only two diſtilled liquors, that, according to the common eſtimation of chymiſts, are uncompounded bodies; however, they are each of them readily diſſoluble in water, and in one another. Take, then, of oil of vitriol, and of ſuch ſpirit of wine as is totally inflammable, an equal weight; mix them together, by degrees, leſt the heat they will produce, ſhould cauſe ſome inconvenience; and having digeſted them, with a very wary management of the fire, draw off what will come over; and you ſhall obtain, beſides a ſubtile and odoriferous ſpirit of wine, and an acid, ſulphureous liquor, a conſiderable quantity of chymical oil; which I have had ſometimes deeply coloured, and ſometimes clear like fair water. Nay, it has ſometimes been exceeding fragrant, and without any acidity at all; tho' the taſt of it was very ſubtile and piercing, but no way like that of any ſaline liquor I know: whence we may doubt, whether it is made of the ſpirit of wine, or of the oil of vitriol. The circumſtances laſt mentioned ſeem to perſuade the former; eſpecially ſince I found, by trial, purpoſely made, that this oil would readily mix with good ſpirit of wine, which had never been concern'd with oil of vitriol: but, on the other ſide, it ſeemed conſiderable, that the oil of vitriol, by this operation, was much weaken'd and changed; and it appeared not whence the ſpirit of wine ſhould have ſo great a fragrancy. Beſides, this oil was ſo ponderous, as to ſink not only in common water, but in the acid ſpirit it ſelf; which ſeemed to be the remains of the alter'd oil of vitriol. But I need not be ſolicitous to determine, which of the two liquors afforded this ſtrange oil; for it may well be compoſed of both, by their mutual action, and the operation of the fire. If it be ſaid, that this inflammable ſubſtance is made by the extrication of the parts which lay concealed in the liquors, before they were brought together; it may be anſwer'd, that till this be prov'd, our cauſe is favoured by the experiment, wherein there appears nothing ſo likely as a change of texture, to produce our anomalous, chymical oil; ſince it plainly ſeems to reſult from two bodies, whereof neither was a true oil before. For each of them would readily mix with water; whereas this oil of ours being ſhaken with water, would break, like common oil, into numerous little globules, which, preſently after, ſunk to the bottom, and re-united there into a liquor, that I have kept, for ſeveral weeks, in the water, and found it, at laſt, undiſſolved thereby.

Some odd properties of this oil make it ſeem likely to participate of the nobler parts of vitriol; and the ſulphur of that having extraordinary virtues aſcribed to it, by ſome of the moſt famous and intelligent chymiſts, I kept a quantity of this oil, for ſeveral years, to obſerve the alterations that time would produce in it; and afterwards I imparted the medicine; the firſt trial whereof prov'd very ſucceſsful.

And tho' chymiſts ſhould prove, that our oil was but ſeparated from the ſpirit of wine, or the oil of vitriol, in which it was latent before; the experiment would ſtill afford a conſiderable reaſon for queſtioning a principal point in the vulgar chymical doctrine; wherein 'tis confidently pretended, that, from the number of ſuppoſed ſimilar ſubſtances afforded by a mix'd body, it was actually compounded of a ſet number of diſtinct and true material principles, and a determinate quantity of each. For if from a diſtilled liquor, as the oil of vitriol, or from alcohol of wine, which is commonly reputed uncompounded, a liquor of quite another kind may be ſeparated; how little reaſon have we to take it for granted, that every diſtilled liquor, ſuppoſed one of the component principles of the body that afforded it, is a homogeneous ſubſtance, not further diviſible into different parts?

And in conſiſtent ſulphurs.

As for the production of that kind of ſulphur, which goes under the name of inflammable ſpirits, it is ſufficiently conſidered in treating of vinous ſpirits. But what I have hitherto ſaid, indeed, relates only to inflammable liquors; whilſt it may be pretended, that ſulphur, in its proper and primary acceptation, ſignifies a mineral body. But, as we formerly ſaid, the chymiſts uſe the term ſulphur ſo ambiguouſly, that 'tis hard to avoid the confuſion which they ſeem to have affected; yet, becauſe the moſt intelligible and particular notion their writings ſuggeſt of ſulphur is, that 'tis a combuſtible and inflammable principle, I have hitherto treated of it as ſuch. And as for that ſubſtance which is commonly known by the name of ſulphur, tho' there are chymiſts, who have affirmed they can ſeparate ſuch a ſulphur from vegetables and animals; yet ſince they teach us not the way of doing it, nor give us any proofs, beſides their own words, that they have done it themſelves, the thing has ſeemed improbable to the more judicious of their own party; only a follower of *Glauber* I find to have undertaken, by his maſter's directions, to produce a real ſulphur, like the mineral, out of vegetable charcoal, by a way, which, becauſe it has deceived more than him, and is ſpecious enough to impoſe upon the leſs cautious, I ſhall here ſet down and examine, as I made it after the author.

We took equal quantities of good oil of vitriol, and of common ſea-ſalt, diſſolved in as much water as was requiſite; this mixture we ſlowly diſtilled, till the bottom was thoroughly dry; then ſetting aſide the liquor, we took out the *Caput mortuum*, and having beat it to powder, with $\frac{1}{4}$ or $\frac{1}{8}$ part of its weight of charcoal, we put it in a ſtrong crucible, and kept the mixture melted in a vehement fire, till it grew of a dark, reddiſh colour: by this time ſuch a change was made in the maſs, that it both ſmelt and taſted rank of ſulphur; and if ſpirit of ſal-armoniac were ſeaſonably diſtill'd from it, with a moderate fire, the aſcending ſpirit would be manifeſtly impregnated with ſulphur, that was eaſily ſeparable; which may alſo be by ſeveral other ways obtained from the ſame fixed *Caput mortuum*.

I do not, however, take the ſulphur thus produced, to have been the vegetable ſulphur of charcoal, but a mineral one, that lay conceal'd, in a liquid form, among the ſaline parts of the oil of vitriol.

For 'tis not likely, that ſo ſmall a quantity of charcoal as was employ'd in this experiment; and much leſs, that ſo ſmall a quantity as may ſuffice to make it, can contain ſo much ſulphur, as might this way be obtained.

And that common vitriol is not deſtitute of mineral ſulphur, appears from the ſulphureouſneſs of the marcaſites whereof 'tis uſually made. So that in ſeveral countries, as about *Liege*, and in ſome parts of *Italy*, from the ſame ſubſtance that affords vitriol, they obtain, by diſtillation, great quantities of common ſulphur, which is ſold for ſuch to other countries. And I have found, that there may be obtained from vitriol, an oil, and a *Caput mortuum*, which, put together, afford an intolerable ſcent of common ſulphur.

And I have, ſeveral times, purpoſely try'd, that by diſtilling together common oil of turpentine, and common oil of vitriol, the former of thoſe liquors would make a ſeparation of ſome of the ſulphur, that lay concealed in the latter, and as it were extract it; ſo that, beſides an exceedingly ſulphureous liquor, which was ſometimes made white by the diſſolved ſulphur that paſs'd into the receiver, we had in the neck of the retort, a yellowiſh, ſolid body; which being put upon quick-coals, would, after a little yellow flame, afford much bluiſh flame, like that of common ſulphur, which it alſo reſembled in ſmell. And ſuch a kind of ſulphur I have alſo ſeen, in tract of time, ſettle it ſelf, in conſiderable quantities, at the bottom of the liquor diſtilled from the mixture of the two oils above mentioned. Nor are theſe the only ways by which I have obtained from oil of vitriol manifeſt proofs of its containing a mineral ſulphur, very like the common ſort.

And, in particular, I once put into a retort, one part of running mercury, and four of oil of vitriol; and having diſtill'd off the menſtruum by degrees of fire, there remained at the bottom of the glaſs a very white powder; which being afterwards gradually urged with a ſtronger fire, afforded, in the upper part of the retort, a great many ſmall bodies, that looked like half beads of amber. Theſe, by their aptneſs to melt, by their ſmell, and by the bluiſh flame they afforded when burnt, appeared to be a kind of ſulphur; which ſeems far more unlikely to have proceeded from ſo homogeneous a body as quick-ſilver, than from the oil of vitriol; wherein we have ſhewn there are many ſulphureous as well as acid corpuſcles. And as upon uniting the oils of turpentine and of vitriol in a due proportion, I conſtantly obſerved, that they incorporated into a mixture that was deeply red; I ſuſpected the chymical cauſe of this phenomenon might be, that the oil of turpentine made a ſolution of ſeveral ſulphureous particles it met with in the oil of vitriol; as we ſee that common flowers of ſulphur give a redneſs to the oil of turpentine, when diſſolv'd therein. And accordingly I found, that ſeveral other chymical oils, and even oil of aniſeeds, wou'd preſently acquire the ſame colour, when carefully incorporated with a due quantity of oil of vitriol.

As to the ſulphurs of metals and minerals, I confeſs I have not yet found enough, either in chymical writings, or my own experience, to let me ſpeak poſitively about them. It may be doubted, whether the ſulphurs that are ſometimes obtainable from minerals, belong'd to thoſe minerals, as eſſential ingredients; or were only corpuſcles of common ſulphur, perhaps a little alter'd, and mingled in the bowels of the earth, with other parts eſſential to the mineral. Thus we ſee in native cinnabar, the mercury which chymiſts ſuppoſe a compleat metal of it ſelf, is ſo mix'd with another body, as not to be diſtinctly diſcernable till ſeparated by the fire. And from this cinnabar I have, ſometimes, by an eaſy way, obtain'd a ſulphur. Since alſo, as we lately noted, the vitriolate marcaſites afford much common ſulphur by a groſs method of ſeparation, it ſhou'd ſeem probable, that ſome common ſulphur may remain more cloſely mix'd with the ſaline and metalline parts of the vitriol, afforded by the ſame marcaſites; from which latent corpuſcles of ſulphur may, in part, proceed the ſulphureous ſmell, *&c.* obſerv'd in vitriol and its oil. And, perhaps, the ſame conſideration may account for the ſulphureous qualities ſometimes found in the liquors that paſs for the vinegars of mineral bodies; and particularly antimony; to which may, now and then, be added ſome metalline ores; for I have had ſuch a ſulphureous liquor from good lead-ore, dug out of the mine at *Minedeep.* And that nature her ſelf may blend an imperfect mineral with lead, I have obſerved in an ore of a mine ſo different from the other ores of the ſame country, that I did but diffidently gueſs 'twas a natural mixture of lead and antimony, till particular tryals had juſtified my ſuſpicions.

But tho' chymiſts pretend to teach us ways of extracting the true ſulphurs of minerals and metals; and tho' I know, from experience, that a real combuſtible ſulphur may be, in a conſiderable quantity, obtained from antimony; yet chymiſts often deceive themſelves and others, by miſtaking thoſe things for the true ſulphurs of minerals and metals, that really are not ſo. Of this I ſhall give a plain inſtance, in the preparation that many of them deliver of the ſulphur of antimony. For when they have boiled that mineral in a ſtrong lixivium

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of pot-aſhes, they ſuppoſe, that, as by the ſame operation common ſulphur is diſſolv'd, ſo the menſtruum ſeeks out, and takes up, only the ſulphureous parts of the antimony: and as common ſulphur is precipitated out of the lixivium, wherein 'tis diſſolv'd, by adding vinegar, or ſome other acid to it; ſo they preſume, that what is ſtruck down by the ſame way, from the ſolution of antimony, made in the ſame menſtruum, muſt be the true ſulphur of that mineral; and in this they are confirmed by the colour. And yet, in reality, not only the ſulphur, ſuppoſing there is one, but the other parts of the antimony, will be diſſolv'd by a ſtrong lixivium; and the yellow powder that is precipitated, is but a kind of crocus, which will ſometimes ſubſide of it ſelf, without the help of an acid. Nor does it ſhew, that ſuch a body, obtain'd from a mineral or metal, is its true ſulphur, becauſe it may be made to burn; for unleſs the colour and ſmell of the flame concur, I ſhou'd ſuſpect, that the inflammability may be apt to ariſe from the great comminution of the prepared body, and from the addition employed in preparing it. For theſe two may ſo greatly contribute to the inflammable diſpoſition of a body, that little or no ſulphur will be neceſſary to make it burn. Thus when an equal weight of ſublimate has been diſtill'd from plates of copper, the remaining maſs will melt and burn at the flame of a candle, almoſt as readily as ſealing-wax. And it may be made appear, that combuſtible and inflammable bodies conſiſt of parts which, ſingly, had no ſuch quality; yet the contrary of this is ſuppoſed in the argument, that from ſuch qualities infers the preſence of ſulphur in all thoſe mineral preparations wherein they are found. I wou'd not, however, be thought to derogate from the medical virtues of ſuch ſuppoſed ſulphurs; for they may be very uſeful concretes, tho' not true principles; the finer parts of the mineral being in ſome of theſe preparations extracted and further divided, and, perhaps, very luckily aſſociated with the finer parts of the body employed to act on them: by which means there may reſult new ſubſtances of great virtue and uſe. And to obtain theſe magiſteries from metals, I employed no acid menſtruum or liquor made of a particular ſalt; but a neutral or compounded ſalt; which, whilſt it was in actual fuſion, wou'd diſſolve or corrode the metal that was reduced to thin plates. But there is another ſort of bodies obtain'd from ſome minerals, and perhaps from metals too, that has a greater reſemblance to mineral ſulphur than theſe crocus's.

By putting *Aqua fortis*, in a certain proportion, upon crude antimony, and, after it was almoſt totally diſtill'd off, increaſing the fire till a dry ſubſtance began to ſublime, we had, in the upper part of the retort, a yellow brittle ſubſtance, which being carefully ſeparated from the dark-colour'd antimonial powder, that was alſo elevated by the force of the fire, appeared not only by its own colour, but that of its flame, and ſome other ſigns, to be much of the nature of common ſulphur: and this is not the only way whereby we have obtain'd ſuch a ſubſtance from crude antimony, which has yielded us a yellow and combuſtible ſulphur, even without the help of a menſtruum. *Paracelſus*, indeed, pretends to a way of drawing ſulphurs from all metals; but becauſe I am not able to reduce it to practice, nor clearly to underſtand his meaning, and the true nature of the inſtruments he wou'd have employ'd, I will not take upon me to determine, whether the ſulphurs he teaches to be obtainable, by this method, be genuine, and fit to decide the preſent queſtion.

However, we have ſometimes by cementing very thin plates of a certain metal with burn'd alum, and afterwards dexterouſly elevating the more diſpos'd parts with ſal-armoniac, obtain'd a ſublimate, from whence we ſeparated, by ablution with fair water, that diſſolved the ſalt, a ſubſtance, which, by its inflammability, appeared a kind of metalline ſulphur.

But, probably, even this ſort of bodies, drawn from a metal, and from antimony, may not be the effects of a bare ſeparation of pre-exiſtent ſulphur, from the other ingredients of the ſubſtances that yielded them; but new concretes, produc'd by the operation of the fire on thoſe bodies, and by the combination of ſome of their parts with thoſe of the addition, employed to obtain the ſulphurs. For, as far as I have yet ſeen, either ſalt-petre, crude or diſtill'd, menſtruums made of it, other kinds of ſalts, or oleaginous liquors, are employ'd on theſe occaſions. And 'tis very poſſible, that ſome of the more diſpoſed parts of them may aſſociate with thoſe of the mineral or metal, to be wrought upon; and ſo from this combination of the ingredients, there may reſult a body of a new texture, which texture may diſpoſe it to be combuſtible or inflammable, whether the ingredients, in their ſeparate condition, were ſo or not. Thus tho' *Aqua fortis* be not inflammable, nor a piece of crude copper inflammable or combuſtible in a common moderate fire; yet the metal being diſſolv'd in *Aqua fortis*, and the ſuperfluous moiſture warily exhaled, there will remain a fuſible concrete, wherein the copper, being much comminuted, and its ſmall parts fitly aſſociated with the ſaline ones of the menſtruum, compoſes a kind of vitriol, that, being held in the flame of a candle, or even of a piece of paper, will readily burn away in a finely colour'd flame, which may be kept diſtinct from the other.

In ſhort, it ſeems not improbable, that, if any of the metals be, by a fit menſtruum, or proper ingredient, reduc'd to parts minute enough, and theſe parts be fitly aſſociated with ſome of thoſe of the menſtruum, the metal may, thereby, be brought to burn or flame; as I have ſucceſsfully tryed upon gold it ſelf, whoſe ſulphur the chymiſts wou'd have us look upon as incombuſtible; ſo that for ought yet appears, 'tis allowable to ſuſpect, that the ſulphur obtain'd from a particular metal, is not ſo much an elementary or hypoſtatical principle, barely extracted, as a magiſtery, or ſome other new compound, made by the combination of the metalline particles, with the body that works on them. But if a chymiſt will have metalline preparations of this kind, to be ſulphurs, I may be allowed to make them ſerve for inſtances of the produciblene ſs of ſulphurs.

SECT. IV.

Mercuries producible.

CHYMISTS have given us no ſettled notion of their mercury, but have left us to gueſs what they mean by it. That which ſeems agreed on by moſt of them, when they ſpeak a little intelligibly of the principle mercury, is, that 'tis a fluid ſubſtance, or volatile liquor, which therefore may be diſtinguiſhed from the ſaline principle, eſpecially from the alkaline, or fixed ſalt; as it may alſo be from the oil or ſulphur, by its not being inflammable. But theſe marks will not diſcriminate it from phlegm, which is alſo a fugitive and uninflammable liquor; and therefore to make the difference, they muſt add ſome other quality, ſuch as taſt, which is wanting in phlegm. So that, according to this doctrine, the nature of a chymical mercury, or ſpirit, will conſiſt in its being a volatile liquor, not inflammable, like oil or ſulphur, nor yet inſipid like phlegm. But what a principle muſt this be, that comprizes ſuch different bodies, as acid ſpirits, as thoſe of nitre and vitriol; the urinous, as for inſtance, thoſe of blood, hartſhorn, *&c.* and the anonymous, as thoſe of guaiacum, honey, *&c.* freed from their acidity; and the running mercuries of minerals and metals, as cinnabar, antimony, and lead? But as for the mercuries, or uninflammable ſpirits of vegetables, and animals, I have endeavour'd to ſhew their production, in treating of ſpirits and volatile ſalts. And, therefore, I need only now ſpeak to the production of mercury, more properly ſo called, that is, running mercury.

Whether running mercuries are obtainable from metals and minerals.

That there may be extracted, or obtained from metals and minerals, a fluid ſubſtance, in the form of running mercury, is the common opinion of chymiſts; and in their writings we may meet with many proceſſes to make theſe mercuries.

But ſeveral of the more learned chymiſts themſelves, have look'd upon the pretenſions of others to the art of making them, as a chimera; and ſome judicious modern writers have exploded all theſe mercuries of bodies as meer non-entities; nay, ſome do not ſcruple to cenſure all thoſe who pretend to have ſeen, or made any of them, as credulous, or impoſtors.

I here propoſe to examine, whether from a metal, or mineral, there may, without the addition of any ſubſtance, that certainly contains common quick-ſilver, be obtained, by art, a ſubſtance reſembling that drug:

drug in weight and fluidity, in amalgamating with gold, and ſome other metals, and in being indiſpoſed to wet or ſtick to bodies, that are not of a metalline nature.

Now there are ſeveral proceſſes of making the mercuries of bodies, ſo darkly deliver'd, that the generality of chymiſts cannot underſtand them, ſo as to put them in practice.

For ſome of theſe proceſſes are ſet down in terms of art, which, for their great darkneſs or ambiguity, are utterly unintelligible, but by the authors themſelves, or thoſe who are vers'd in the more myſterious parts of hermetic philoſophy. And others there are of theſe proceſſes, that require ſome menſtruum, ſalts, or other inſtruments, not in the power of ordinary chymiſts to procure.

Inſtances of this kind frequently occur in the writings of ſuch as paſs for the adept philoſophers; for inſtance, in *Lully*'s method of making mercury of ſilver; *Helmont*'s way of preparing mercury of lead; and *Paracelſus*'s way of extracting the mercuries of all metals.

Again; there are ſeveral proceſſes to make mercuries of bodies, either falſe, or attended with ſuch circumſtances, as render them unfit to be truſted.

Some of theſe having been cautiouſly try'd, by thoſe who had a great deſire to find them true, have not ſucceeded at all in practice. Hence we have ſo many complaints of ſuch chymiſts as have loſt their labour in endeavouring to make, according to *Beguinus*'s directions, the mercury of ſilver; tho' I do not take that to be one of the moſt difficult to be prepared: and he who converſes with thoſe who have attempted to make the mercuries of gold, antimony, *&c.* according to the vulgar proceſſes, will find, by their confeſſions, how little the event has anſwer'd their expectations. Nor do all the manuſcript proceſſes, communicated to private friends as great arcana, much excel the other; as ſeveral of my acquaintance have found to their coſt. Among the many chymiſts I have known, I remember not above three or four credible perſons who would affirm, they had ever prepared the mercury of any metal or mineral, except of native cinnabar, which is the natural ore of quick-ſilver; or ſeen it made, in a conſtant way, by any proceſs found in printed books. So many of theſe methods having, therefore, upon trial, been found falſe; cautious men may be excuſed believing other proceſſes for making mercury, which, tho' not yet try'd, ſeem no more probable, than thoſe that have been found unſucceſsful.

But farther; there are ſome proceſſes, wherein it is thought, that the mercury of a metal, or mineral, is obtained, when, indeed, the produced ſubſtance is miſcall'd; or the true mercury ſaid to be extracted, was put in diſguiz'd by the operator.

I will not here give inſtances of the cheats that may be put upon the ignorant and unwary, and ſometimes too upon the ſkilful, if they be not cautious; but ſhall content my ſelf with a few innocent examples.

And,

Chymiſtry.

And, firſt, there are ſome, who finding themſelves unable to make the true mercuries of metals or minerals, aſcribe the name of mercury to productions, whoſe qualities are very remote from thoſe agreed to be eſſential to quick-ſilver. Thus *Glauber* ſpeaks much of his mercury of *Luna*, which yet is far from being running mercury; or having the ponderoſity, and other properties of true quick-ſilver. So *Angelus Sala*, in his anatomy of antimony, would have us to look upon the regulus of that mineral as its mercury; becauſe he takes it for granted, it muſt contain mercury; and fancies no other can be obtained from it. To ſhew that the mercury obtained by ſome proceſſes which ſeem to ſucceed, made part of the addition employed by the artiſt in the operation, I might have recourſe to an eaſy inſtance, a deluding experiment that I made, by mixing the filings of copper with a certain ſalt, and putting them in a glaſs veſſel held over the fire, till the ſalt is thoroughly melted, and in part ſublimed; by which operation, the copper ſeems to be quite changed, eſpecially in colour; while there remains in the lower part of the glaſs a conſiderable quantity of running mercury.

Laſtly, it is poſſible to obtain from ſome metals and minerals true running mercury, or quick-ſilver, that cannot juſtly be thought to proceed merely from the addition.

Having diſtilled copper with certain ſaline ſubſtances, I was not a little ſurprized to find, in the veſſels that had been luted together, ſome globules of running mercury, which I could not reaſonably ſuſpect to come from the addition, that was not ſublimate; nor any thing I could judge to contain quick-ſilver. I afterwards found, that accidents of the like nature had been obſerved by ſeveral of my friends.

A chymiſt of my acquaintance preſſing me to communicate to him a way of making the mercury of antimony and of lead; to be rid of his importunity, I told him what, on a ſudden, came into my thoughts; and after I had forgot this affair, he came with great joy, to return me thanks for the inſtructions I had given him; bringing along with him ſome mercury of antimony, and a little mercury of lead, that he had already made by the help of them. And by the ſame means he expected to obtain much more mercury from the minerals, when they ſhould be longer digeſted with the concourſe of the air in thoſe ſalts, that I had adviſed him to grind therewith.

Two gentlemen of my acquaintance, tho' unknown to each other, working, almoſt at the ſame time, upon ſilver, found parts of that metal turned into running mercury; with which odd accident each of them came to acquaint me; bringing along with them a little portion of the mercury. One of the parcels I found not to be common, but metalline mercury; and the artiſt complained to me, that he ſometimes had conſiderable quantities of it, to his great loſs; becauſe much of the ſilver he employed, in an operation that he expected would prove gainful, being turned into quick-ſilver, had ſwallowed up all his profit:

and this invited him to apply himſelf to me, hoping to find a remedy for this inconvenience.

A fellow-traveller of mine, employing a ſaline body about lead; after he had finiſhed his operation, left the lead and ſalt together, for ſome months, in a veſſel, which he laid by in a garret, where the air had acceſs to it; and he afterwards found, to his wonder, that tho' he had employed no mercurial body to work upon the lead, yet part of it was turned into quick-ſilver, ſeparable by ſtraining; and more ſeemed in a ready diſpoſition to undergo the like change. Whereupon he brought me a part of the metal, and a little of the mercury, which I found, by experience on gold, to be of a nobler kind than common mercury. And I the leſs wonder'd at this phenomenon, becauſe, by examining the gentleman, I diſcover'd, that the principal thing he employed in the operation was common ſalt.

We took three ounces of well refined ſilver, in thin plates, and ſix of common ſublimate, which was put firſt into a retort; the ſilver cut into ſmall pieces, being laid uppermoſt, that it might be penetrated by the aſcending fumes: but the fire having not been made ſtrong enough, the ſublimate was elevated to the upper part of the retort, and left the ſilver ſcarce at all chang'd in the bottom of the glaſs. Wherefore, we put the ſame ſublimate and metal into another retort, and applying a ſtronger fire, that the ſublimate might be thoroughly melted before it could fly away, we obtained no running mercury at all; but the greateſt part of the ſublimate was elevated in its uſual form; leaving behind it, the ſilver in a lump, which ſtuck hard to the bottom of the glaſs, and appeared much alter'd. It had gained an ounce in weight, and many pieces of the metal ſtuck together, and ſeemed at leaſt half melted; and were of a kind of horny and ſemi-diaphanous ſubſtance, which would readily melt, almoſt like ſealing-wax, when held to the flame of a candle, at which yet I could not perceive it manifeſtly to take fire.

An expert metalliſt of my acquaintance, being deſirous to try what gold and ſilver he could get out of a fine *Engliſh* marcaſite I had preſented him; he examined it, according to his method, without any mercurial preparation, and found, to his ſurprize, that it yielded, beſides other things, ſome running mercury, which he gave me.

Metalline mercuries produce heat in mixing with gold.

More than one of my friends have made the mercury of antimony, by unſuſpected additions, ſuch as ſalts, that had nothing to do with ſublimate, or other compoſitions, wherein common mercury is an ingredient. One of theſe antimonial mercuries looked ſo odly, that, tho' it were made by diſtillation, I try'd whether it would not operate on gold in a peculiar manner; and having, accordingly, put a little fine calx of that metal into the palm of my hand, I added to it an equal, or a double weight of this mercury, which immediately incorporated with a very manifeſt heat. And this is my quick way of examining other mercuries of bodies; for tho' alone it be not a certain ſign, that a mercury is of that ſort, becauſe I can obtain a mercury ſo qualified, by a different method from any hitherto mentioned; yet as I had ſufficient reaſon to conclude, that they obtained thoſe mercuries from the bodies they affirm'd to have yielded them, ſo the readineſs of theſe mercuries to mix with gold, without the help of fire, and even to grow hot with it, which vulgar mercury will not do, confirmed that they were metalline mercuries, rather than of the ſame kind with common quick-ſilver. And my way of obtaining incaleſcent mercury, is ſo very different from any of thoſe, that there was not the leaſt cauſe to ſuſpect, the mercuries of the reſpective bodies were ſo obtained; eſpecially ſince I knew that my way was unknown to moſt of the perſons mentioned, and practiſed by none of them. *Chymiſtry.*

Having prepared a particular mercury of this kind, I put to one part thereof, ſometimes half its weight, and ſometimes an equal weight of refined gold, reduced to a calx, or ſubtile powder; and mixing them together in the palm of my hand, they grew, in the ſpace of a minute, conſiderably hot. The effect was by much the greater, for employing an equal weight of gold. Nor did the interpoſition of a paper between the metals and the hand, prevent, tho' it much abated, their heat.

Theſe experiments were made but with ſmall quantities of the mercury; but if we had employed larger, to a due proportion of gold, 'tis probable, the heat might have been intenſe enough to crack a glaſs vial; for a dram of it has ſometimes cauſed me to lay it ſuddenly out of my hands. This mercury was ſo well diſpoſed to gold, that it would preſently amalgamate with an equal quantity thereof, into a hard mixture; wherein the mercury ſo far prevailed, as quite to aboliſh the colour of the gold. And the power of penetrating and growing hot with gold, was ſo eſſential to our mercury, that after it had been frequently diſtilled from that noble metal, it ſtill retained this property: nay, even a ſingle dram of it, after having lain by for three or four years, grew ſo hot with gold, that I feared it would have burnt my hand. And to try, whether this ſurprizing faculty of growing hot immediately upon gold, wou'd continue for a ſtill longer time in the mercury; I took ſome that I had kept, hermetically ſealed up, for ten or twelve years, and having put it to ſome common calx of gold in the palm of my hand, it preſently grew hot: and having diſtilled off the mercury, and tried it again, it did, as well as ſome that was undiſtill'd, again heat with gold.

And, by the way, we may obſerve, that a mercury qualified to grow hot with gold, and perhaps with other powders, may be made by more methods than one or two; for experience has aſſured me, that ſuch a mercury may ſucceſsfully be prepared, not only by employing antimony, and ſuch ſolid metals as iron, but even without any metal or antimony. But the gold muſt be duly prepared for this trial: the ſmalleſt filings I could procure, were not fine enough for the purpoſe. Nor will every calx of gold ſerve the turn; that which

I principally choſe, was made by quartation, or the melting together one part of fine gold, and three or four parts of cupell'd ſilver, and then putting the maſs, wherein the metals are mixed almoſt *per minima*, into purified *Aqua fortis*, which diſſolving only the ſilver, leaves the gold in a fine calx. But there being ſome difficulty in obtaining this calx pure, I will add, that by making an amalgam, in the common way, with pure gold and vulgar mercury; and diſſolving the mercury in good *Aqua fortis*, there will remain a powder, which being well waſh'd with fair water, and kept a while in a moderate fire to dry, will become a proper calx for this purpoſe. And to ſhew, that the heat in this experiment proceeds not from the corroſive particles of the *Aqua fortis*, employed in preparing the gold; I put upon fine leaf-gold, two or three times its quantity of our mercury, and a ſmart heat was immediately produced in my hand. I put two drams of antimonial quick-ſilver into the palm of my hand, and added to it, by degrees, a dram and half of the powder of fine ſilver, made by precipitation with copper, in the ordinary way; when mixing them with my finger, I found they grew ſenſibly warm. And this mixture, in a ſhort time, became of a ſoft and uniform conſiſtence, almoſt like melted butter; ſo that we added half a dram more calx of ſilver, without rendering the amalgam too ſtiff; and, perhaps, we might have added another half dram, without overcharging that piercing mercury; in which caſe it would have ſwallowed up full its own weight of ſilver: ſo different was it from common mercury. And when we left off, it had reduced into a very yielding form, three quarters of its own weight of ſolid metal. This amalgam we put into a ſmall vial, and ſtopt it up with cork, to obſerve, whether it would harden when kept from the free air. Next morning it appeared to be concreted in the glaſs; and breaking the glaſs on the morning following, to take out the matter, we found it conſiderably hard and brittle.

As for the mercury of gold, tho' I have brought a great many parts of that crude metal to aſſume a mercurial form, and to come over therein by diſtillation, yet I have not ſeen any thing, that I was ſatisfied deſerved to be called mercury of gold. But a foreigner, who ſeem'd a candid gentleman, and, as I perceived, had ſeen uncommon things, and who ſhewed me one whereat I was ſurprized, aſſured me, that he had met with a very learned man, in compariſon of whom he confeſſed himſelf but a novice, who put ſome gold into a little vial of a certain menſtruum, which this gentleman knew not how to prepare; and intimated to him, that the menſtruum would have a peculiar operation, as well upon gold as ſilver; and my relator having put the vial, well ſtopp'd, into his pocket, and carried it about with him, was, when he came home, and took it out, ſurprized to find, inſtead of the gold he had ſeen put in, a conſiderable quantity of running mercury. This the artiſt, who only lent him the menſtruum, did not ſeem to think ſtrange, when made acquainted with it.

Chymiſtry.

I have here been careful to mention only thoſe relations, to which I my ſelf ſaw cauſe to give aſſent. If theſe inſtances be ſuppoſed caſual experiments, whilſt there appears no ſettled way for the obtaining the mercuries of bodies, I might alledge, that ſome paſſages here deliver'd make it probable, that even ſettled methods of making the mercuries of ſome bodies, are not unknown to ſome artiſts. And tho' moſt of theſe experiments may be ſaid to have been caſual in this reſpect, that thoſe who made them did not principally deſign to obtain metalline or mineral mercuries; yet the effects produced were as naturally and neceſſarily conſequent upon operations ſo managed, as if the artiſt had directly deſign'd them; which in ſome of theſe caſes they did. And it is not material to enquire, whether the quick-ſilver, made in thoſe experiments, be owing to chance or skill; ſince it is plain, that if metals and minerals cou'd, by either way, be actually brought to afford running mercury; there needs no more to prove that ſuch mercuries are really obtainable from them.

Whether the mercuries of metals and minerals be pre-exiſting principles, and only extracted from them, may ſeem ſuperfluous to enquire; ſince the generality of chymiſts, of different ages and countries, have reſolutely determin'd the affirmative. This, however, is not at all to be wonder'd at, ſince, according to their hypotheſis of the *tria prima*, whereof they preſume all perfectly mix'd bodies to be compoſed, metals muſt conſiſt of mercury, as well as of ſalt and ſulphur; and conſequently afford it upon the analyſis of the body into its three primordial ingredients. But notwithſtanding this, the problem ſeems difficult to be reſolv'd: for ſuppoſing there are true metalline mercuries preparable by chymiſts; they very ſtudiouſly conceal the ways of their preparation. And as 'tis very difficult to obtain any of the factitious mercuries, wherewith to make the proper tryals; ſo thoſe few authors who affirm themſelves to have poſſeſs'd ſuch mercuries, give us but an exceeding lame and defective account of them; ſtudiouſly omitting thoſe particulars which are moſt requiſite in order to form a right judgment about them. For my own part, I am, at preſent, inclin'd to think, that the mercuries obtain'd from metals, do not clearly appear to have been pre-exiſtent in them; and that, at leaſt, ſome of them, may be rather fluid magiſteries of metals, than their principles. One of the moſt obvious things that ſuggeſted this ſuſpicion to me was, that whilſt ſome metals, as tin and lead, were in fuſion, they wou'd to one, who ſhou'd not know of their being melted, appear to be parcels of mercury; ſince, like it, they are fluid and ponderous, and ſtick not to the crucible, or to ſtones, bricks, or almoſt any other bodies, except metalline ones; ſome of which they will eaſily pierce into, as quick-ſilver does into ſilver or gold; ſo that if the fluidity of theſe metals were permanent, they might well paſs for mercuries. And if in the moon as there are mountains, ſo there ſhou'd alſo be metalline mines, in caſe the heat of the climate, or of the ſoil, ſhou'd keep them conſtantly in ſuch a degree of heat, as we find ſufficient to melt lead, which need not be very intenſe, theſe metals wou'd there imitate our mercuries. Thus I have learn'd from travellers, that in ſeveral parts of the torrid zone, what would here be butter, is there fluid like oil, and ſold, as other liquors, by meaſure, not by weight. And an inquiſitive traveller aſſured me, that whilſt he was in ſome parts of the *Indies*, having furniſh'd himſelf with ſome liquid ſubſtances from wounded plants; as ſoon as he came near *Europe* they turned into conſiſtent and pulverable bodies: it is not therefore impoſſible, that the piercing ſalts, and other ſubtile bodies, employed in preparing the mercuries of metals, may, either by their natural agility, and by ſo altering the ſhapes, and looſing the coheſion of the metalline corpuſcles, bring them to ſuch a texture as may ſuffer the etherial ſubſtance, whereto ſo many other bodies owe their fluidity, to agitate them. Theſe cauſes, or ſome other, may poſſibly keep the prepared metal fluid. Thus tho' camphire be a conſiſtent and tough body, yet ſome nitrous ſpirits will eaſily penetrate it, and may be brought to ſtay ſo long with it, that I have kept the oil of camphire for ſeveral years, without loſs of its fluidity, tho' expos'd to ſuch intenſe degrees of cold as would freeze ſeveral other liquors. And ſince the vapour of lead can arreſt quick-ſilver, and make it a conſiſtent body; and ſince *Helmont* aſſures us, that the liquor alkaheſt being once abſtracted from running mercury, deprives it, and that almoſt irrecoverably, of its fluidity, ſo as to make it pulverable; why may not nature or art ſupply ſome corpuſcles to expel or diſable thoſe that keep a metal in the form of a ſolid; eſpecially ſince the matter of metals themſelves may have been a fluid body. Another reaſon why I ſuſpect the mercuries of metals and minerals not to be merely extracted principles or ingredients, is, that I have obſerved a greater diſſimilitude between running mercuries, furniſhed with all that is requiſite to make them paſs for true, than agrees to their being ſimple and primordial bodies, barely extricated from the others, with which they were at firſt mix'd; as we ſhall ſee hereafter. The chymiſts, alſo, who talk of the mercuries they have drawn from metals, do not tell us what other ingredients they obtain'd by their ſuppoſed analyſis; which leaves it dubious, whether they obtain'd any ſalt or ſulphur or not; and of what nature thoſe ſubſtances were that they did obtain. For if theſe were not true ſalt and ſulphur, the genuineneſs of the analyſis might be queſtion'd; becauſe it may be alledg'd, that the chymical operation, and the addition, turning ſome parts of the earth into bodies, which muſt not be acknowledged to have pre-exiſted in them, may alſo, by a change of texture, have turn'd ſome other parts of the metal into the form of mercury.

And to give the ſanction of an adept, *Raymund Lully*, tho' he often ſpeaks of mercury in a dark and allegorical ſenſe, yet in his *Clavicula*, he delivers a proceſs, from whence it ſeems manifeſt, that his deſign was not to extract a pre-exiſtent quick-ſilver; ſince he directs us to proſecute the work till the quick-ſilver obtained, be equal in weight to the ſilver to be tranſmuted; whereby it appears, that the mercuries of bodies are rather magiſteries than extracts. For in this proceſs of *Lully* it appears not, that the mercurial principle was extracted from the ſalt and ſulphur; but rather that the body of the metal, without being analyzed, was turn'd into mercury. Magiſtery is, indeed, a term variouſly employed by chymiſts, and, particularly, 'tis uſed by *Paracelſus*, to ſignify different things; but the beſt notion I know of it, is, that which I find authoriz'd even by *Paracelſus*, where he expreſſes himſelf more diſtinctly, I mean, a preparation whereby there is no analyſis made of the body aſſign'd, nor an extraction of any particular principle, but almoſt the whole body is turn'd into a ſubſtance of another kind: as when iron or copper, by an acid menſtruum that corrodes and aſſociates therewith, is turn'd into vitriol of iron or copper; and quick-ſilver, by having a ſufficient quantity of *Aqua fortis*, ſtrongly abſtracted from it, is chang'd into red precipitate; or by being ſublim'd with common ſulphur, is turn'd into cinnabar: or to give a more appoſite example, when quick-ſilver is, by the laſting operation of the fire, without external additions, diſtinct from the particles of fire, turn'd into a red powder, call'd precipitate *per ſe*.

I am credibly informed, and have ſome proof of the thing, that there is a place in *Tranſylvania*, where portions of running mercury falling out of the earth, and lying a while in the air, of themſelves coagulate into bodies permanently hard: ſo little difference hath nature her ſelf there made between the mercurial fluidity, and the ſolid conſiſtence of the ſame portion of matter. If, therefore, ſo ſmall a thing as the contact of the air can expel, is able, by its preſence, to retain a mineral body in the form of a true running mercury, as well as by its receſs to leave it ſolid; why ſhou'd it be impoſſible for art to intercloſe ſome very minute and reſtleſs particles, which, by their various and inceſſant motions, may keep a metalline body in the ſtate of fluidity; as I lately noted, that the ſpirit of nitre, for whole years together, kept camphire in the form of a liquid oil?

But it may be objected, that quick-ſilver eaſily amalgamates with metals; becauſe of its near alliance to the mercurial part of thoſe bodies, and that the gravity of the metals is ſuch, as cannot reaſonably be deduced from any other cauſe than an abundance of the mercurial principle.

To this I anſwer, that amalgamation being, in effect, but a kind of diſſolution of metals, in a menſtruum or fluid body, for ſuch is mercury with regard to them, there is no neceſſity that the ſolvent ſhou'd find, in the metal, a copious ingredient juſt of its own nature; for diſſolution depends not ſo much upon the pretended affinity be-

Chymiſtry.

Beſides, a fluid form does not always argue the lightneſs of the body wherein it is found; ſince it may conſiſt of particles ſo ſolid and numerous, that notwithſtanding their inteſtine motion, the body they compoſe may be very ponderous; as appears by red-hot iron, melted lead, and in common quick-ſilver, which, tho' fluid, is heavier than any known body except gold.

But farther, tho' the ſolid portion of a metal retain more of the additions employ'd to bring it into the form of mercury, than it can be prov'd to contain; yet, this diſadvantage may be compenſated, by the new diſpoſition of parts that the mercurial portion acquires in the operation which turns it into a liquor; and may be ſuppos'd to bring the parts to a cloſer, or more convenient order than they were in before; as ice, when thaw'd, takes up leſs room than when ſolid. And 'tis not impoſſible, that the ſpecific gravity of metalline bodies may be increas'd or diminiſhed by ſuch ſmall proportions of additions, as do not at all conſiderably add to their abſolute gravity. This the chymiſts ought not to deny, after what they grant of the efficacy of that they call the philoſopher's ſtone, whereof they tell us, that one grain, if it be of a nobler order, or degree, may tranſmute a whole pound of quick-ſilver into perfect gold; whence, conſequently, the ſpecific gravity of a metal is vaſtly chang'd by an addition. Beſides, the tranſmuting powder, being a compound body, whereof only a part is gold, it may probably be ſuppos'd to be more light *in ſpecie*, than the metal, that by addition thereof is produced; which being pure gold, is the moſt ponderous body yet known. And there is a way of making a metal far lighter *in ſpecie* than it naturally is, by the addition of leſs than a 100*th* part of its weight; as experience has convinc'd me.

Wherefore, to come to the grand objection drawn from *Lully*'s experiment, it will not preſently follow, that, if the whole body of a metal be brought into a mercurial form, this mercury deſtroys our hypotheſis; for tho' I grant it cannot here be ſaid, as in the former caſes, where a part only of the metal is turn'd to mercury, that the obtain'd quick-ſilver may conſiſt of the moſt ſolid and ponderous parts of the metal; yet it may ſtill be alledg'd, that, for ought we know, the mercury produc'd by the reduction of the whole metal into a fluid form, will be ſpecifically lighter than common mercury; and ſo cannot be neceſſarily concluded ſpecifically heavier than the metal that afforded it. I have, indeed, had portions of the mercuries of more than one or two metals, yet it was but in ſmall quantities; ſo that the other trials I made with them, prevented me from examining their ſpecific gravity hydroſtatically. But, that quick-ſilver may be ſpecifically lighter than the metal which affords it, the chymiſts cannot reaſonably deny; ſince they allow running mercury to be obtainable from gold; and tell us great matters of it, becauſe of its proceeding from ſo noble a body. Now, if this mercury of gold be ſaid to be of the ſame ſpecific weight with common quick-ſilver, we have a notable inſtance of a mercury conſiderably lighter, *in ſpecie*, than the metal that yielded it. And therefore, till experience has manifeſted the contrary, it will not be abſurd to preſume, that the mercuries of other metals may, likewiſe, be lighter, *in ſpecie*, than the reſpective bodies from which they were obtain'd: but if it be ſaid, that this mercury of gold, may be as ponderous as gold it ſelf; then 'tis poſſible for a metalline body, notwithſtanding its being reduced into the form of a fluid, to be equiponderant to the metal that afforded it. And to confirm this, I ſhall add, that it is poſſible for a metalline body to reſemble another in all the manifeſt qualities whereby artiſts examine them; and yet to differ greatly from it in ſpecific gravity; as I once obſerved in a metal, that was not only white, like ſilver, and very malleable, but when purpoſely examined, endured cupellation, and was reputed by a very eminent artiſt, who ſent it me to examine, to be good ſilver in all proofs; and yet this metal I found, by hydroſtatical trials, to be much lighter, *in ſpecie*, than common ſilver. And if this famous perſon was not miſtaken, that odd metal may yield me a notable inſtance to my preſent purpoſe; ſince he affirm'd it to be made of quick-ſilver, without the addition of any metalline body: for if ſo, that fluid muſt, by a change of texture, have ſuffer'd a conſiderable loſs in its ſpecific gravity. And once I had a mercury, which, amongſt other remarkable properties, was conſiderably heavier, *in ſpecie*, than common mercury, tho' it were made of a body no heavier, and by the help of additions much lighter than that. This quick-ſilver looked very fine, was very agile, and had, before I examined it, been more than once diſtill'd. Hence it appears, that while a body is in a mercurial form, we cannot ſafely determine what degree of ſpecific gravity it has. For ſince a ſort of quick-ſilver may be far more ponderous than the common; 'tis probable, that another ſort may be far lighter than that; and ſo, perhaps, lighter than the metals reduced into that form: for 'tis far leſs likely, that the former ſhould be produced, than the latter; becauſe there is but one known mineral body at all heavier than common quick-ſilver; whereas there are many much lighter than it, which are capable of being aſſociated therewith.

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In ſhort, the argument I have been anſwering is not cogent, becauſe built upon a ſuppoſition, that the mercuries afforded by metals and minerals muſt be of the ſame weight with common mercury; which is a bare aſſertion, without any proof, and repugnant to the experiment juſt mentioned, of the diſtilled mercury, that was heavier than the common; and to the preſumption thence derived, that there may be bodies in a mercurial form, lighter, *in ſpecie*, than common mercury. And ſince pure gold is far more ponderous than common quick-ſilver, it plainly appears, that it is not to the participation of common mercury, that metals muſt neceſſarily owe their great weight; but that nature and art may contrive the parts of a body into ſo cloſe an order, as to make it more ponderous, bulk for bulk, than common quick-ſilver.

And here it may be proper to inquire, whether all the bodies, that in ſhops, and among chymiſts, paſs for true running mercuries, are homogeneous, or, ſo much of one and the ſame nature, that the ſeveral portions of them differ but numerically.

Running mercuries not homogeneal.

I have ſome obſervations to make upon this queſtion, that will determine it in the negative; tho' both chymiſts and naturaliſts employ all running mercuries indifferently.

1. And, firſt, it is obſervable, that a running mercury may be brought to differ from common quick-ſilver, by depuration; for there are in moſt mercuries, either recrementitious particles, or at leaſt ſome looſe adherences, ſeparable from the reſt of the body; which being removed, the mercury becomes more homogeneous, or clean, than before. The like end is alſo obtainable, by grinding, or waſhing the mercury very well with ſalt and vinegar, or ſpirit of wine; which will commonly be foul'd by what they carry off. And mercury is ſometimes attempted to be purified by diſtillation; which, tho' in ſome caſes inſufficient, is in others very convenient. And artiſts uſe other means to the ſame purpoſe. No wonder then, if chymiſts themſelves, before they proceed to more intimate preparations of mercury, order it to be, ſeveral times, previouſly incorporated, and ſublimed with acid ſalts or ſulphurs, and then revived with alkalies; ſince, according to mechanical principles, it muſt thus be divided into exceeding minute globules; whence it acquires far more of ſurface than it had before; ſo that a great multitude of ſeparable parts come to be touch'd almoſt on every ſide by the ſalts and ſulphurs, whereto, by this means, when the quick-ſilver is driven from them in the revivification, 'tis probable, that very many of them adhere, which were not ſuperficial, when all theſe globules made up but one maſs. And, 'tis poſſible too, that the alkalies employed to revive the quick-ſilver, may help to tear off from it ſome of the feculent particles, which the chymiſts deſire it ſhould be freed from. And, by the way, there is no neceſſity to have recourſe to ſalt of tartar, or quick-lime, or ſuch like alkalies, for the reviving of quick-ſilver; and, therefore, when I would, with eaſe, obtain a clean and active mercury, I do not employ firſt acid, and then alkaline ſalts, but thoroughly mix common cinnabar, finely powder'd, with a double, or an equal weight of filings of iron, or ſteel; for theſe being diſtilled together in a low retort, with a briſk fire, the ſulphur of the cinnabar will faſten upon the filings, and let the mercury come over fair and vivid, and, perhaps, impregnated with a ferruginous quality.

2. There is, alſo, another way of diverſifying mercury by impregnation; as when ſome ſubtile parts of another body, are ſo intimately aſſociated and united therewith, that not only the addition will paſs with the mercury, when ſtrained thro' leather, but, alſo, continue with it after diſtillation, whilſt the mercury ſtill remains very vivid. I know there are many chymiſts, who look upon quick-ſilver

as a mineral, wherein no other body can faſten, ſo as to alter it intrinſically, or ſuffer it to be aſſociated intimately, or permanently therewith. And, indeed, ſince we find that when gold it ſelf, whereto, of all bodies whatſoever, mercury is allowed to have the greateſt analogy, may yet be ſeparated from it, by committing an amalgam of thoſe two metals to leather; which will tranſmit the quick-ſilver, and retain the gold; and ſince if ſuch an amalgam be diſtilled with a competent fire, the mercury will aſcend, and leave all the gold behind in the retort; it ſeems improbable, that mercury ſhould be more intimately aſſociated with any other bodies: but theſe arguments, tho' ſpecious, are not ſatisfactory; for the corpuſcles of ſome mineral bodies may be ſo well mixed with quick-ſilver, as to paſs with it through the pores of leather; and I have found, by trial purpoſely made, that quick-ſilver being in a convenient proportion amalgamated with tin or lead, and diſtilled with a competent fire, will manifeſtly bring over with it ſome of the aſſociated metal; ſo that I have not only found a conſiderable increaſe in the weight of the diſtilled quick-ſilver, but it would both leave a tail behind it upon a ſloping glaſs; and when this ſluggiſh mercury had reſted a while, it appeared cover'd over with a kind of ſcum, made of the emerging corpuſcles of the tin or lead; either of which, eſpecially the former, is a metal lighter, *in ſpecie*, than quick-ſilver. Hence it appears, that mercury may be ſo united to a conſiderable proportion of a groſs, ponderous body, of an ignobler kind, as to carry it along with it ſelf in diſtillation; which, therefore, ſeems not to be near ſo certain a way, as ſome learned chymiſts think it, to try whether mercury be pure; and to free it from adulterating mixtures. Since we ſee then, that mercury does not refuſe even groſs impregnations, it is not incredible, that it may, in ſome caſes, admit more ſubtile ones; and ſo intimately aſſociate with it ſelf ſome of the finer parts of certain metals and minerals, as not to part with them by diſtillation, or repeated ablution. I had once a diſtilled mercury, made by an impregnation of common mercury, a globule whereof being evaporated from a thin piece of ſilver, not only ſeemed to have penetrated the plate, but left upon it a rugged ſubſtance, of a colour very near that of gold. But that common mercury may be impregnated with fine particles, I have been perſuaded by ſeveral effects of ſuch impregnations: and moſt of the uncommon mercuries, I ſhall hereafter mention, were prepared after ſome ſuch manner.

3. Another thing wherein a mercury may differ from common quick-ſilver, is a facility to amalgamate with gold; for, 'tis known to gilders, goldſmiths, *&c.* that to make amalgams with gold and mercury, 'tis uſual to take ſix parts of the latter to one of the former. And notwithſtanding ſo large a proportion of mercury, they make both that and the gold conſiderably hot to facilitate their mixture; but I have often had ſubtily impregnated mercuries, with but two parts thereof,

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I could preſently make an amalgam with one part of the calx, or leaves of gold, without any other external heat, greater than that of the palm of my hand. Nay, ſometimes, I have employ'd but one part of quick-ſilver to make a mixture; wherein the gold was ſo far from appearing, that the colour of the quick-ſilver ſeem'd not ſenſibly impair'd.

4. Another difference between ſome mercuries, and thoſe that are vulgar, is, that theſe being put to calx of gold, tho' they are, at length, brought to mix, yet they will not diſcloſe any ſenſible heat; but the mixture, like each of the incorporated ingredients, will to the touch ſeem cold. But I have often found, that a diſtill'd mercury may be ſo invigorated, that a ſingle dram of it, or, perhaps, a far leſs quantity, being barely mix'd by my finger, with as much, or half as much calx of gold, would preſently conceive a conſiderable heat, which would, as was formerly ſaid, ſometimes, prove offenſive to the palm of my hand, wherein I held it. And to convince a very eminent chymiſt, that there were ſuch mercuries as theſe, I took a remnant of certain quick-ſilver, of whoſe diſpoſition to incaleſcence I had ſuch an opinion, that tho' we had no calx, nor ſo much as filings of gold, but only ſuch pieces as could be obtain'd by a hammer and a pair of ſciſſars; I ventured to put it to them in a glaſs mortar, when, notwithſtanding the thickneſs and cloſeneſs of the beaten metal, and the coldneſs of the veſſel, the mercury, to the artiſt's ſurprize, penetrated the gold, and grew manifeſtly hot with it. And this faculty of our quick-ſilver was not tranſient; for I had kept this parcel of it by me for ſeveral years. The incaleſcent mercuries, hitherto mentioned, were invigorated by tedious and laborious operations; but I know, by experience, a way, tho' it be hard to hit, that will in an hour, and perhaps in leſs time, qualify mercury to grow preſently hot, tho' in a manner vaſtly inferior to the former.

5. When an invigorated mercury is, by due impregnation, qualified to amalgamate readily and intimately with gold, and penetrated ſo as preſently to grow hot therewith, it is not ſtrange that it ſhould alſo differ from common mercury, in being able to carry up with it part of the gold, wherewith it was ſo ſtrictly aſſociated. I know, 'tis often thought incredible, that crude gold ſhould be volatiliz'd by quick-ſilver; and, indeed, the common ſort may be many times diſtill'd from gold, without carrying up any of it; but with a very ſmall quantity of a mercury, ſubtilly impregnated, I have elevated ſo much calx of gold, that the inſide and neck of the retort, were richly gilt by the adherent particles of that metal, which would ſometimes ſtick ſo cloſe, as not, without difficulty, to be ſeparated from the glaſs: and having, with one of theſe noble mercuries, amalgamated about half its weight of calx of gold, tho' it did not gild the inſide of the glaſs, yet I found, that the diſtill'd mercury was manifeſtly increas'd in weight, and ſomewhat changed in colour and conſiſtence.

Chymiſtry.

6. Upon diſtilling an amalgam, made with one of theſe ſubtily impregnated mercuries, and the calx of gold, I have obſerv'd a large part of the bottom of the retort, to be left adorn'd with a very lovely colour, almoſt like that of a turquoiſe ſtone, inclining to yellow, and ſomewhat changeable; and the ſtain ſeem'd to have penetrated the glaſs, tho' left by a very ſmall quantity of the amalgam; and tho' the mixture were diſtill'd but in a ſand heat. And another amalgam of gold, with an invigorated mercury, being long decocted, the veſſel broke, and left the lower part of the glaſs permanently ting'd with a pure and tranſparent red, that ſeem'd to reſemble a fine ruby.

7. I have found another ſurprizing difference between ordinary quickſilver, and ſubtily impregnated mercuries; for tho' one would expect that mercuries ſo piercing, and ſo diſpos'd to adhere cloſely to gold, ſhould make with it amalgams, far more eaſy than thoſe made with ordinary quick-ſilver, to be turn'd into red precipitate; yet I found the contrary upon trial. Chymiſts mention about ſix weeks, as the uſual time wherein mercury may be precipitated *per ſe*; and allow but a ſhorter time, to make this precipitation, when 'tis amalgamated with gold; but I have kept invigorated mercury, amalgamated with about a third part of its weight of fine gold, for above three months, without having ſo much as a grain of precipitate, that I could perceive; tho' the mercury grew hot with the gold at their being mingled, and tho' the whole were kept in a heat, able to make quick-ſilver circulate. This I try'd with other ſorts of invigorated mercury; but, in above five or ſix months, obtain'd not a ſingle grain of precipitate; tho' the heat was ſo ſtrong, as to carry up many parts of the quick-ſilver, and of the gold with it, to the top of the glaſſes. Nay, the fire was ſo violent, that one of the hermetically ſeal'd glaſſes beginning to melt, the ſpirituous matter, included in it, was ſo forcibly expanded, as to ſtretch the weaker ſide of the veſſel, and make it bulge out; tho' it did not break. Nor is the ſpace of ſix months, the longeſt term, during which I have kept gold in decoction with invigorated mercuries, without obtaining a red powder, or precipitate; ſo that as far as I have yet try'd, the more ſubtile, and richly impregnated mercuries, are far leſs apt to afford precipitates with gold, than common quick-ſilver is. As if that diſpoſition, to be turn'd into powder, required the preſence of the recrementitious, or more ſeparable part of quick-ſilver, which a chymiſt would perhaps call its ſulphur. This, I confeſs, was a diſappointment to me; for I had hopes of making a precipitate with gold, and ſome of theſe noble and richly impregnated mercuries, that ſhould prove a bettter medicine than precipitates made with gold and only common mercury; tho' even of ſome of theſe, when dexterouſly prepared, and kept their due time in decoction, I have ſeen great effects, when exhibited in a juſt doſe, and prevented from raiſing a ſalivation.

8. The laſt difference I ſhall obſerve between ſome diſtill'd mercuries and common quick-ſilver, is their inequality in point of ſpecific gravity.

I ſhall not here obſerve the different taſts of different creatures, or of the ſame at different times, and according as the object is applied; but methink the conſideration of quick-ſilver may let us ſee, that 'tis poſſible for a groſs and fluid body to be inſipid. For quick-ſilver is, without queſtion, a fluid, and in regard to ſome bodies, as gold, ſilver, *&c.* a liquor; ſince it ſokes into their pores, and ſoftens their bodies. The ſame quick-ſilver may ſhew, by its diſpoſition to fly away in the fire, that volatility, even in conjunction with inſipidity, is no certain mark of an elementary or primordial body. And indeed, ſince volatility principally depends upon the extraordinary minuteneſs of the particles whereof a body conſiſts, on their being detach'd from one another, and of ſhapes fitted for motion; this quality may be acquired by ſo many different ways, and be met with in bodies otherwiſe of ſuch different natures, that unleſs it be found aſſociated with the other qualities proper to phlegm, it will be but an uncertain argument to prove the body, it belongs to, elementary.

Of all the bodies employ'd in chymiſtry, thoſe that ſeem the moſt indiſpoſed to be turn'd into water, are metals and minerals; if, therefore, it can be made appear, that any of this ſort are changeable into an aqueous liquor, 'twill be highly probable, that aqueous liquors may, by chymical operations, be produced, eſpecially in vegetable and animal bodies, which ſeem far more ſuſceptible of ſuch a change, than the ſtubborn ſubjects of the mineral kingdom. And ſince quick-ſilver is generally allowed to be one of the moſt indeſtructible bodies in nature; and, by its great ponderoſity, to be ſo much the more remote from ſuch a liquor as water, that has not the ſixteenth part of its ſpecific weight; if this can be turn'd into an aqueous liquor, it will greatly favour our doctrine.

From quick-ſilver.

Relating to a very ingenious and ſober phyſician of my acquaintance, that in diſtilling mercury, without addition, I once obtain'd a water, but could not make the like experiment afterwards ſucceed; he aſſured me, that he, and a friend of his, having provided a very large *Dutch* retort of good earth, furniſhed with a pipe, and, by degrees, convey'd thro' that pipe a pound of quick-ſilver into the retort, made red-hot, they obtain'd four ounces of water, and loſt two ounces of matter; the remaining part of the pound being elevated in the form of mercury: and the receiver, he ſaid, was not applied, till the retort had been made thoroughly glowing hot; ſo that this liquor could not be the aqueous particles of the earth of the veſſel. He added, that the liquor was very different from common water; becauſe, pouring both their diſtill'd mercury, and their water, into a kind of *China* cup, they left them open, in a garret, for two or three days in *June*, upon a preſumption, that this mercurial water, thus order'd, would turn a part of the quick-ſilver into its own nature, and ſo multiply it ſelf upon it; but coming to their cup again, they were much ſurpriz'd to find the water all gone, and the greateſt part thereof turn'd into mercury; which they concluded, becauſe they miſs'd, upon the balance, but about half an ounce of the whole matter, that was they ſuppoſed to have been loſt by evaporation; the other three ounces and a half being found in the additional weight of the mercury.

And tranſmutable into other bodies.

And if *Helmont* ſays true, that by his liquor alkaheſt, not only quick-ſilver, but all other tangible bodies, may be reduced into inſipid water, juſt like rain water; I may infer, that water may be produced, ſince ſalt and ſulphur themſelves may be turn'd into it. I know the *Helmontians* might anſwer, that this is not ſo much a production, as a reduction, ſince all things conſiſting originally of water, the alkaheſt does but deprive it of the diſguizes that ſeminal principles put it into, to make it appear under the form of gold, quick-ſilver, plants, animals, *&c.* But even by this anſwer 'tis granted, that water has actually been produced, in plenty, out of mineral bodies, tho' it has not yet been made appear, that thoſe bodies were produced out of water. But ſuppoſing bodies, by the alkaheſt and the fire, were really reduced into water; *Helmont* farther relates, that by abſtracting his immortal liquor from ſtones, or ſuch kinds of bodies, he turned them into ſalt, equiponderant to the concrete; which ſalt, by further operations, he reduces, as he ſuppoſes, into elementary water. Since then he ſtops not at ſalt, but goes to a further tranſmutation; and concludes, that a ſtone doth not conſiſt of ſalt, becauſe that ſalt may be turn'd into inſipid water; I ſay, that inſipid water is not the firſt matter of bodies; ſince, by a farther operation of the fire, that liquor it ſelf may be turn'd into earth. For clear water, ſeveral times very ſlowly diſtill'd out of clear glaſs bodies, has every time left me a terreſtrial powder at the bottom; as if the whole body of the water might, by repeated diſtillations, without violence of the fire, be reduced into earth; whereof, in my laſt trial, I had enough to cover the bottom of a large cucurbit, out of which the diſtillations had been made.

And I ſhall here add an experiment, which ſeems to argue, that without the help of repeated diſtillations in tall cucurbits, clear water may, by the operation of the fire, be changed into another body.

We put very pure and limpid water, which had, by our pneumatic engine, been carefully freed from its aerial particles, into a new bolt-head, of ſuch a ſize, that the matter might have room to play, and circulate; and ſealing it up hermetically, we placed the veſſel in a digeſtive furnace, and left it there above a year; and obſerved, that after it had continued for a conſiderable time, there began to form themſelves in the water little concretions, heavier than it; which at length increaſed in magnitude, and, as we thought, in number; making a kind of *terra foliata*, that conſiſted of a multitude of little thin films, or ſcales, like thoſe of the ſmaller ſort of fiſh; which, when the glaſs was ſhaken in an enlightned place, were plentifully difdiſpers'd thro' the body of the liquor, and appear'd variouſly and ſtrongly colour'd; ſome whereof were almoſt as big as ſpangles, but more glittering: and when the agitation ceaſed, they preſently fell to the bottom, and cover'd it. And the longer the glaſs was kept in the digeſtive furnace, the more of this fine terreſtrial ſubſtance was produced. But leſt the effect ſhould be aſcribed to the abſtraction of the air, I muſt add, that we produced the like ſubſtance, tho' not ſo plentifully, after the like manner, in water that had not at all been freed from air.

SECT. VI.

Earth a heterogeneous principle.

OF all the ſubſtances obtainable from mix'd bodies, that which to perſons, not prepoſſeſs'd with *Helmontian* opinions, may ſeem the moſt ſimple, elementary, and unchangeable, is, what they call earth, or *terra damnata*; becauſe it ſeems highly probable, that the calcining violence of the fire, muſt not only have driven away the mercurial, and other volatile parts, but have quite burnt out the ſulphurs, which are often more fixed than the reſt; as the water, on the other hand, is ſuppos'd to have diſſolv'd away all the fixed ſalt.

This reaſoning, I confeſs, is plauſible, but not ſatisfactory; for as the particulars wherein this ſuppoſed ſimplicity, and unchangeableneſs of the earthy part of mixed bodies is founded, are its not diſſolving in water, its not affecting the taſt, and its not having flown away from the incinerated body; it may, with probability, be doubted, whether any of theſe, or all of them put together, neceſſarily prove what the chymiſts pretend.

And producible.

And, firſt, according to the different conſtitutions of certain bodies, we muſt diſtinguiſh between the dry and heavy parts that remain, after a body has been expos'd to the violence of the fire; and, if need be, freed from its ſalt as much as poſſible, by the affuſion of water. For 'tis evident, that in ſome bodies, eſpecially of a metalline nature, the calcining fire does not operate, as in the burning of vegetables; ſince ſometimes almoſt the whole weight of a mineral is to be found in what they call its calx; as is manifeſt in the calcination of tin and lead *per ſe*. And this calx is, in great part, reducible, ſometimes into a body of the ſame nature with that which afforded it, and ſometimes into another body, very far from being elementary, as appears in the reduction of minium; which, as to the greateſt part of it, we have more than once, by the bare manner of ordering the fire, reduced, in a very ſhort time, and without addition, into malleable lead; and alſo in the aſhes of antimony, which, by bare

fuſion,

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fuſion, are eaſily reduced into glaſs; whence we have ſometimes obtained an antimonial regulus. So that 'tis plain, there is a great difference between the aſhes of metals, and of ſome minerals; where almoſt the whole body is, by the fire, converted into a dry and heavy powder, and the aſhes of incinerated vegetables; which uſually leave but little earth behind them, in compariſon of the matter which the violence of the fire drives away.

But ſetting aſide the metalline *Calces*, which, without queſtion, remain compounded bodies, if metals themſelves be ſo; and to forbear examining, whether they be not farther compounded with corpuſcles of the fire or fewel; the qualities which make other aſhes paſs for elementary earth, may be produced in portions of matter that are not ſimple, either by compoſition, or change of texture.

In various bodies.

There are ſubſtances, which tho' when ſingle, they will eaſily diſſolve in water, yet the reſult of them will not; whereof we have inſtances among the magiſteries of ſeveral bodies, made by precipitating their ſolutions in acid liquors, with oil of tartar *per deliquium*.

From oil of vitriol, and ſpirit of wine, tho' both moſt readily diſſoluble in water, we have, by bare digeſtion and diſtillation, obtain'd a large quantity of a ſubſtance, that we found not diſſolvable in water, inſipid and fixed.

There are ſtones, alſo, which I could, by the help of the fire, deprive of their colour, and bring to a white powder; yet it did not appear, that they were really calcin'd, or would in water yield any ſalt. So that if ſtones be compound bodies, there may be other corpuſcles, beſides metalline ones, which, tho' reduced by the help of the fire to a white powder, inſipid, and not diſſoluble in water, are yet very remote from an elementary nature.

And chymiſts themſelves teach us, that the aſhes of wood may, by the violence of the fire, be turn'd into glaſs; which being a body compos'd of the earthy and ſaline part of the aſhes, (for they ſay, that earth ſeparated from the ſalt, will never vitrify,) muſt, according to their own confeſſion, be a compound body; which being, at laſt, made by the utmoſt violence of the fire, muſt be fix'd, indiſſoluble in water, and conſequently inſipid. But without taking this vitrification upon the chymiſts authority, 'tis manifeſt, that in glaſs, made after the common way, there is a great deal of lixiviate ſalt mixed with the ſand; for artificers find the ſalt neceſſary to diſſolve and fuſe the ſand: and the glaſs uſually weighs ſometimes thirty or forty pound in an hundred, more than the ſand that was put in.

And ſince chymiſts aſcribe all odours to ſulphur, I may reaſonably conclude againſt them, that, in ſpite of all the violence of fire, which is required to the making common glaſs, there is plenty of ſulphur, as well as ſalt, in it; for I have often try'd, that by barely rubbing two pieces of glaſs one againſt another, there would quickly be produced a ſtrong offenſive ſmell. And yet glaſs, which thus appears to be not only a compounded, but a re-compounded body, (becauſe the ſand, and other ſtones, being themſelves mixed bodies, are further compounded with the ſalts that diſſolve them) manifeſtly poſſeſſes all thoſe three qualities, which chymiſts require in their earth; for 'tis taſtleſs, indiſſoluble in water, and fix'd in the fire. And if aſhes of themſelves, be capable of vitrification, as chymiſts teach, and as the maſter of a glaſs-houſe told me he once found, with ſome difficulty; how are we ſure, that in common aſhes, freed, after the uſual way, from their fixed ſalt, what is called a ſimple earth, may not be a body compounded of two or more ſubſtances, which, by their coalition and new texture, produced by the action of the fire, have been brought to a kind of vitrification; or have otherwiſe acquired the obvious qualities that chymiſts think ſufficient to give a production of the fire the name of earth?

'Tis obvious, that ſeveral bodies, when of a ſenſible bulk, will ſink in liquors wherein their corpuſcles would freely ſwim, if many of them did not ſtick together. Thus lumps, and the grains of ſalt and ſugar, will fall to the bottom of water, in which, when they are diſpers'd into minute and inviſible particles, they will eaſily float. And I have obſerved in ſtopp'd glaſſes, that ſome ſalts, and other bodies, that, for many months, remained undiſtinguiſh'd in the liquors that harboured them, would, in tract of time, have conventions made of their particles, which then ſubſided; and be no more carried up and down by the particles of the liquor. And ſomewhat of this kind may, perhaps, happen to the particles whereof water conſiſts; for if ſome of theſe, by frequent occurſions and attritions, come to apply themſelves to one another, ſo as to have a fuller and more immediate contact than formerly; to be entangled among themſelves; and, perhaps, alſo, to exclude ſome very thin and ſubtile air, that lurks about them, and contributes to their ſuſtentation; the cluſters, tho' as to ſenſe but very ſmall, may prove too great and unweildy to be, any longer, parts of water, but may ſubſide in that liquor; and if their adheſion be ſtrong, they will, upon the ſame account, become unfit to riſe up in the form of vapours and exhalations, by heat, and ſo may be, like earth, fix'd in the fire, as well as indiſſoluble in water.

I have ſometimes, alſo, ſuſpected, that the production of an earthy ſubſtance in water, may be further'd by the particles of the fire, employed to make it circulate; and that of thoſe particles which pervade the glaſs, ſome of the leſs ſubtile may, in their paſſage, faſten themſelves to ſome aqueous particles, fitted to adhere to them; and with theſe begin to make ſome inviſible concretions, to which, afterwards, other congruous particles may gradually adhere in their paſſage; and ſo at length compoſe ſenſible aggregates of powder. Thus in the precipitation of quick-ſilver, without addition, the mercurial particles aſſociating themſelves with; and, probably, with ſome of thoſe of the fire; begin to form concretions, at firſt very minute, which afterwards increaſe, by the acceſſion of other adhering particles, till all the mercury, or the greateſt part of it, be reduced, from a fluid body, to a red powder. And it may countenance this conjecture, as to the production of an earthy ſubſtance, by a briſk concurrence of the particles of fire, to add, that tho' I have kept highly rectified ſpirit of wine, for above a year together, hermetically ſeal'd up, and for the greateſt part of that time, in a digeſtive furnace, without finding any earthy reſidence; yet, when I order'd a bolt-head, that, tho' it were hermetically ſeal'd, the alchohol of wine it contain'd, might be boil'd without breaking the glaſs; I found, in a ſhort time, that this liquor would afford a conſiderable quantity of ſuch a ſubſiding talky ſubſtance, as I obtain'd from the water formerly mention'd.

Two parts of tobacco-pipe clay, finely powder'd, and very well mix'd with one part of pulveriz'd cryſtals of nitre, being put into a crucible, and kept, for three hours, in a violent fire, the mixture was afterwards taken out, and the remaining fix'd ſalt, carefully extracted; but it amounted to a very little, in compariſon of what nitre uſually yields when calcined with charcoal; and, that this ſmall proportion of fix'd ſalt did not, principally, proceed from any very large avolation of nitrous ſubſtance, appear'd probable, becauſe the *Caput mortuum* was much more ponderous than could be expected upon account of the tobacco-pipe clay firſt employ'd, and the alkali extracted; ſo that the new weight, acquired by the clay, ſeem'd manifeſtly to proceed from the acceſſion of a portion of the ſalt-petre, that, by this operation, was turn'd into earth; ſo that of ſix drams, which four ounces of clay had acquir'd in weight, after the crucible was taken out, not ſo many grains could, even by boiling water, be obtain'd from the whole *Caput mortuum*; which, when firſt ſeparated from the crucible, was almoſt quite inſipid.

That earth may, *de novo*, be produced, we may likewiſe argue from an experiment we made about the deſtruction of ſalt of tartar, by igniting and putting it into fair water; for there remain'd, after numerous filtrations, and after every ſingle one, a ſubſtance in the filtre, which, for ought appears, may be as well call'd earth, as that which was ſeparated from the calcined tartar, the firſt time it was put into the water, to divide the ſalt from the earth. For here, as well as in that common operation, the way of proceeding is the ſame; and in both, there remains in the filtre a ſubſtance, which, by its ſtay there, ſhows it to be indiſſoluble in water; and which, before it came thither, ſhew'd, by enduring a violent fire, that it was alſo fix'd, as earth ought to be. Nor would it much alter the caſe, if this factitious earth ſhould have ſuch an operation upon ſome particular body, as is thought not to belong to true elementary earth. For ſince it is obtain'd by a chymical analyſis, if it have thoſe qualities, that, in the general eſtimations, make up the notion of earth, that ought to ſuffice, at leaſt, till the

Chymiſtry. miſts give us ſome more accurate definition of genuine earth, ſhew us ſuch a thing, and teach us a better way to obtain it.

And in many bodies, that are reputed earth, I obſerve qualities which belong not to elementary earth, in the receiv'd notion thereof. This, I ſay, becauſe I ſee not why ſuch a texture, as will ſuffice to make a portion of matter indiſſoluble in water, fix'd in the fire, and inſipid upon the tongue, may not alſo fit it to operate, actively, upon ſome bodies; and modify the operations of others that act upon it. And if our earth, obtain'd from ſalt of tartar, be, by the chymiſts, rejected as ſpurious, they muſt confeſs the inſufficiency of their common way of ſeparating a true earth from the bodies they analyze; for, it ſeems, calcination, ſolution in water, and filtration, which make up their uſual method, will not ſuffice to make our earth of tartar paſs for true; tho' it appear not to be near ſo remote from an elementary nature, as ſome other bodies that are obtain'd for earth by the vulgar analyſis. I have found, that the *Caput mortuum* of vitriol, remaining after it had long endured a violent fire, tho' it were diligently freed from ſaltneſs, by repeated ablutions with hot water, was yet far from being an elementary earth; as appear'd by its deep purpliſh colour; its weight, far exceeding that of earth; and by an experiment that I purpoſely made to examine it.

And an acquaintance of mine, who dealt much in *Hungarian* vitriol, affirm'd to me, that he had out of the colcothar of a certain ſort of that vitriol, not only received a conſiderable quantity of good copper; but ſeparated from that copper a large portion of ſilver, and ſome grains of true gold.

No natural elementary earth.

I have not yet ſeen it prov'd, that nature, any more than art, affords us a true elementary earth; at leaſt, I can ſay, that ſome, which ſeem to be of the more ſimple ſort, I found, upon examination, had qualities not aſcrib'd to pure earth. For, tho' tobacco-pipe clay, by reaſon of its fixity, whiteneſs, and inſipidity, and its lying often deep beneath the ſurface of the ground, may as probably as almoſt any other native earth, ſeem elementary; yet tobacco-pipes, well bak'd, may, ſometimes, be made to ſtrike fire: and I have, more than once, try'd, that by briſkly rubbing two pieces of a new tobacco-pipe one againſt another, they would, in a minute or two, grow warm; and being immediately ſmelt to, manifeſtly afforded a rank ſcent, between ſulphureous and bituminous, almoſt like that which proceeds from pebbles and flints, when they are, likewiſe, rubb'd hard againſt one another: as if tobacco-pipe clay were not a true earth, but a fine white ſand, conſiſting of grains, too ſmall to be diſtinctly taken notice of, like thoſe of other ſand. And I found, by a hydroſtatical trial, that its ſpecific gravity was but little different from that of pebbles; its proportion in weight to water of the ſame bulk, being as two and a quarter to one. A tobacco-pipe may be, alſo, ſomewhat melted by a very vehement fire; for it will thereby be brought to bend.

Porcellane, or the matter whereof *China* diſhes are made, is not, as ſome travellers have fondly imagined, a compoſition that requires to be buried under ground, for many years, to ripen; but, as ſome late authors inform us, and as I have been aſſured by a perſon who viſited the place in *China*, ſo famous for making porcellane veſſels, it is a pure ſort of clay; however, I find it not to be elementary earth. For a violent fire will make it ſomewhat melt, and with ſteel it will eaſily ſtrike fire, almoſt like a flint; whereto it approaches in ſpecific gravity. The like I have obſerv'd in porcellane, very artificially imitated with a ſort of *Engliſh* clay. And I found too, that the matter even of dark-colour'd juggs of the better ſort, well baked, wou'd, with a ſteel, afford ſparks of fire. But I once ſaw a pit, where, at the depth of many yards, they dug up a certain white earth, which when diſtill'd, afforded a liquor that I found to be very rich in a volatile ſalt, that taſted and ſmelt much like ſpirit of urine, or hartſhorn; and had almoſt the ſame effects in changing the colours of ſome bodies, and precipitating others. I remember too, that by the operation of a menſtruum or two upon tripoli, that, as white and pure a virgin earth as it ſeem'd, yet it prov'd not elementary. And, on the other hand, the maſter of ſome *Engliſh* mines preſented me a very white ſubſtance, whereof he had plenty, which he thought an earth, and which was judg'd, by an excellent artificer very converſant with tripoli, to be finer even than that earth; but I found it, upon examination, to be a kind of talc, whoſe leaves were exceeding fine and minute. Hence we may reaſonably doubt, whether the aſſertors of elementary earth can ſhew us any native ſubſtance deſerving of that name; and, alſo, whether what remains, after chymical analyſes, tho' it has all the qualities, judg'd ſufficient to denominate a portion of matter earth, may not yet be either a compounded body, or endowed with qualities which belong not to ſimple earth. With this view, I purpoſely examined ſome quicklime, which, tho' it had been, by frequent ablutions in warm water, carefully dulcified, and ſo was as well inſipid as fixed and indiſſoluble in water; yet I found I could readily diſſolve it in ſeveral menſtrua, and even in ſpirit of vinegar; whereas true elementary earth ought to be as well indiſſoluble in ſuch liquors as in water.

THE IMPERFECTION OF THE CHYMICAL DOCTRINE OF QUALITIES.

SECT. I.

The chymical theory of qualities narrow, defective, and uncertain.

THE foundation of all the vulgar chymical theory ſeems to me precarious, and has never been demonſtrated. 'Tis ſtrange, that neither the chymiſts themſelves, nor their adverſaries, ſhould have taken notice, that the analyſis by fire, is not the only inſtrument of diſcovering the ingredients of mixt bodies; ſince, in ſeveral caſes, this may be found by compoſition, as well as by reſolution. Thus vitriol appears to conſiſt of metalline parts, aſſociated, by coagulation, with acid ones, as well by making true vitriol with ſpirit of ſulphur, or that of ſalt, as by reſolving it by the fire.

And whatever chymiſts may be able to obtain from particular ſubſtances, it does not appear, by experience, which is the grand argument they rely on, that all mixt bodies, endowed with qualities, conſiſt of their *tria prima*; ſince they have not been able, truly, and without new compoſitions, to reſolve into thoſe three, gold, ſilver, cryſtal, *Venetian* talc, *&c.* yet theſe bodies have ſeveral qualities; as the two former are fuſible and malleable; and all of them have weight and fixedneſs: ſo that in theſe and the like bodies, whence chymiſts have not yet made it appear, that their ſalt, ſulphur, and mercury can be truly and adequately ſeparated, 'twill ſcarce be other than precarious, to derive the malleableneſs, colour, and other qualities of ſuch bodies from thoſe principles.

Suppoſes things not proved.

A great part of the chymical doctrine of qualities, is, alſo, founded on, or ſuppoſes ſome other things, which, as far as I know, have not yet been well proved; and I queſtion whether they ever will be.

One of their grand ſuppoſitions is, that each particular quality muſt have its πρῶτον δεκτικὸν, or ſome peculiar material principle, to the participation of which, as of the primary, native, and genuine ſubject, all other bodies muſt owe it: but 'twill be hard to ſhew, what is the πρῶτον δεκτικὸν of gravity, volatility, heat, ſound, tranſparency, and opacity; which are qualities to be indifferently met with in bodies, whether ſimple or mixt.

The chymiſts, too, are apt to argue, that, becauſe this or that quality, is not to be truly derived from this or that particular principle; as ſalt, for inſtance, and mercury; therefore it muſt needs be derivable from the third, as ſulphur. But this way of arguing implies, that every quality in a compound body, muſt ariſe from ſome one of the *tria prima*; tho' experience ſhews us, that bodies may, by compoſition, obtain qualities, that were not to be found in any of the ſeparate ingredients. Thus in painting, though blue and yellow be neither of them green, yet their mixture will be green. And tho' no ſingle ſound will make an octave, or *diapaſon*; yet two ſounds, whoſe proportion is double, have an eighth. Tin and copper, melted and mixed together in a due proportion, make bell-metal, which is far more ſonorous than either of them apart. And 'tis obvious for chymiſts to obſerve, that, tho' lead be an inſipid body, and ſpirit of vinegar a very ſharp one, yet *Saccharum Saturni*, a compound of theſe two, is ſweet.

But this ill-grounded ſuppoſition of the chymiſts, is extended farther in an uſual topic of theirs, according to which they conclude, that many qualities, as well manifeſt as occult, muſt be explained by their *tria prima*, becauſe they are not explicable by the four elements of the *Peripatetics*. But to make this argument valid, it muſt be proved, that there are no other ways by which thoſe qualities may be explained, but by a determinate number of material principles.

Is often ſuperfluous.

But there are ſeveral qualities, even in mixt bodies, wherein the chymical doctrine is unneceſſary. For inſtance, when pure gold is, by bare heat, brought to the ſtate of fluidity; and, upon the remiſſion of that heat, grows a ſolid and conſiſtent body again; what addition, expulſion, or alteration of any of the *tria prima*, cauſes this change of conſiſtence? Tho' this is eaſily accounted for in the mechanical way, by the vehement agitation that the fire makes of the minute parts of the gold, to bring it to fuſion; and the coheſion of thoſe parts, by virtue of their gravity and fitneſs to adhere to one another, when that agitation ceaſes. When *Venice* glaſs is merely, by being beaten to powder, deprived of its tranſparency, and turned into a white, opake body, what need have we of the *tria prima* to ſolve this phenomenon?

But further; the chymical doctrine of qualities is inſufficient, and too narrow to reach to all the phenomena that ought to be explicable by it. For there are many qualities, which chymiſts will not attempt to explain; and the ſolutions they give of other particular qualities, are often very deficient and unſatisfactory. Thus, tho' gold be the body they moſt affect to converſe with; yet it will be very hard to ſhew, how its ſpecific weight can be deduced from the three principles, ſince mercury it ſelf is much lighter than gold; and the two other hypoſtatical principles are far lighter than mercury. And, I think, it would much puzzle the chymiſts, to give us an example of a compound body, ſpecifically heavier than the heavieſt of its ingredients.

Again; there are ſeveral bodies, which, tho' the moſt learned chymiſts confeſs, do not conſiſt of their *tria prima*, yet are endowed with qualities, that conſequently are not in thoſe ſubjects to be explained by the *tria prima*. Thus elementary water, tho' never ſo pure, has fluidity, coldneſs, humidity, tranſparency, and volatility, without any of the *tria prima*. And the pureſt earth, as aſhes carefully freed from the fixed ſalt, has gravity, conſiſtence, dryneſs, colour, and fixedneſs, without owing them either to ſalt, ſulphur, or mercury. Since, then, in earth, water, *&c.* ſuch diffuſed qualities, as gravity, fixedneſs, colour, *&c.* muſt be acknowledged not to proceed from the *tria prima*; 'tis plain, that portions of matter may be endowed with ſuch qualities, by other cauſes and agents than ſalt, ſulphur, and mercury; why, therefore, ſhould we deny, that alſo in compound bodies, thoſe qualities may be produced by the ſame, or the like cauſes? Thus the reduction of a tranſparent ſolid to powder, produces whiteneſs, whether the comminution happens to rock-cryſtal, *Venice* glaſs, or to ice: the firſt of which is acknowledged to be a natural, and perfectly mix'd body; the ſecond, a factitious and re-compounded body; and the laſt, for ought appears, an elementary body, or at moſt, a body very ſlightly and imperfectly mixt. And ſo by uniting air in ſmall portions, with a tranſparent liquor, as when we beat ſuch a liquor into foam, a whiteneſs is produced, as well in pure water, which is acknowledged to be a ſimple body, as in white-wine, which is reckoned among bodies perfectly mixt.

And further; the chymical explanations are not ſufficiently extenſive; for moſt of them are not ſo diſtinct and full, as to reach the particular phenomena, nor often ſo much as to all the grand ones, that belong to the hiſtory of the qualities they pretend to account for. A chymiſt will not eaſily ſhew by his ſalt, ſulphur, and mercury, why a load-ſtone, capp'd with ſteel, may be made to take up much more iron, than if it be immediately applied to the iron; or why, if one end of the magnetic needle is diſpos'd to be attracted by the north pole, for inſtance, of the load-ſtone, the other pole of the load-ſtone will drive it away: or, why a rod of iron, being heated red hot, and cooled perpendicularly, will, with its lower end, drive away the flower-de-luce, of a mariner's needle, which the upper end of the ſame rod will draw to it. In ſhort, of above threeſcore properties, or notable phenomena of magnetic bodies, that ſome writers have reckon'd up, I do not remember, that any three have been by chymiſts ſo much as attempted to be ſolved upon their principles. And even in thoſe qualities, in whoſe explanation theſe principles may more probably, than elſewhere, pretend to take place, the chymical accounts are ſo lame and inconſiſtent, that they leave many conſiderable phenomena untouch'd; and but very ſlightly, and in a general way, explain the more obvious or familiar. And, indeed, I cannot but think, that a chymiſt, who, by the mere help of his *tria prima*, takes upon him to account for the qualities of all bodies, acts like him, who, ſeeing a book written in a cypher, whereof he were acquainted but with three letters, ſhould undertake to decypher the whole piece.

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And even when the chymical explanations ſeem to come up to the phenomena, they are not ſufficiently primary and fundamental; for thoſe very ſubſtances that chymiſts call their principles, are each of them endowed with ſeveral qualities. Thus ſalt is a conſiſtent body, has its weight, is diſſoluble in water, is either tranſparent or opake, fixt or volatile, ſapid or inſipid. And ſulphur, according to the chymiſts, is a body fuſible, inflammable, *&c.* and, according to experience, conſiſtent, heavy, *&c.* ſo that 'tis by the help of more primary and general principles, that we muſt explain ſome of thoſe qualities, which being found in bodies, ſuppoſed perfectly ſimilar, cannot be pretended to be derived into one of them from the other. And to ſay, that 'tis the nature of a principle to have this or that quality, as, for inſtance, of ſulphur to be fuſible, and therefore we are not to exact a reaſon why it is ſo; will be of no force, if from the primary properties of bodies, we may deduce any good mechanical explication of fuſibility in the general, without neceſſarily ſuppoſing ſuch a primogeneal ſulphur, as the chymiſts fancy, or deriving it from thence in other bodies. And, indeed, ſince not only ſalt-petre, ſea-ſalt, vitriol, and alum, but ſalt of tartar, and the volatile ſalt of urine, are all of them fuſible; I do not well ſee, how chymiſts can derive the fuſibility even of ſalts obtained by their own analyſis, from the participation of the ſulphureous ingredient; eſpecially ſince, if ſuch an attempt ſhould be made, it would overthrow the hypotheſis of three ſimple bodies, whereof they will have all mixt ones to be compounded: and ſtill 'twould remain to be explained, upon what account the principle, that is ſaid to endow the other with ſuch a quality, comes to be it ſelf endowed therewith. For 'tis plain, that a maſs of ſulphur is not an atomical, or adamantine body; but conſiſts of a multitude of corpuſcles of determinate figures, connected after a determinate manner; ſo that it may be reaſonably demanded, why ſuch a convention of particles, rather than any other, conſtitutes a fuſible body.

And when they tell us, that the fuſibility of bodies proceeds from ſulphur, in caſe they ſay true, they only tell us what material ingredient 'tis, that being diſpers'd through the other parts of a body, makes it apt to melt: but this does not intelligibly ſhew what it is that makes a portion of matter fuſible; and how the ſulphureous ingredient introduces that diſpoſition into the reſt of the maſs wherewith 'tis united: yet they are ſuch explanations as theſe, that a philoſopher chiefly looks after. And to ſhew, that there may be more fundamental explanations, I ſhall only obſerve, that ſulphur it ſelf is fuſible; and therefore, as I lately intimated, fuſibility, which is not the quality of a ſingle atome, or particle, but of an aggregate of particles, ought it ſelf to be accounted for in that principle, before the fuſibility of all other bodies be derived from it. And in ſulphur it ſelf, that quality may be probably deduced from the convention of corpuſcles of determinate ſhapes and ſizes, connected after a particular manner. And if nature, art, or chance, ſhould bring together particles endowed with the like mechanical properties, and aſſociate them after the like manner, the reſulting body would be fuſible, though the component particles had never been parts of the chymiſts primordial ſulphur: and ſuch particles ſo convening, might perhaps have made ſulphur, though before there had been no ſuch body in the world. And though I readily allow, that ſulphur, or another of the *tria prima*, may abound in ſeveral bodies endowed with the quality that is attributed to their participation of that principle; yet this is no certain ſign, that the propos'd quality muſt flow from that ingredient. Thus, if tin, for example, be duly mix'd with copper or gold, ſilver or iron, it will make them very brittle; and it is alſo an ingredient of ſeveral other bodies that are likewiſe brittle; as colour'd amels, which are uſually made of calcin'd tin, (call'd by tradeſmen putty,) melted with the ingredients of cryſtal-glaſs, and ſome ſmall portion of a mineral pigment. But though in all theſe brittle bodies, tin be a conſiderable ingredient; yet 'twere very raſh to affirm, that brittleneſs, in general, proceeds from tin: for provided the ſolid parts of conſiſtent bodies touch one another but in ſmall portions of their ſurfaces, and be not entangled by their contexture, the metalline or other compoſition may be brittle, tho' there be no tin at all in it: and, in effect, the materials of glaſs being brought to fuſion, will compoſe a brittle body, as well when there is no putty colliquated with them, as when there is. Calcin'd lead, by the action of the fire, may be melted into a brittle maſs, and even into tranſparent glaſs, without the help of tin, or any thing elſe. And there are numerous other bodies, that cannot be pretended to owe their brittleneſs to any participation of tin, of which they have no need, if the matter they conſiſt of, wants not the requiſite mechanical diſpoſitions.

And the way employed by chymiſts, and *Peripatetics*, of accounting for things from the materials, whether elements, principles, or other ingre-

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ingredients, of bodies, will often fruſtrate this expectation; for a new quality, differing from, or contrary to, any that is conſpicuous in the ingredients, will frequently ariſe upon their mixture; as two tranſparent bodies may make an opake one; a yellow body and a blue, one that is green; two malleable bodies, a brittle one; two actually cold bodies, a hot one; two fluid bodies, a conſiſtent one, *&c.* And as this way of judging, by material principles, hinders the fore-knowledge of events from being certain, it much more hinders the aſſignation of cauſes from being ſatisfactory; ſo that thoſe who judge of all mix'd bodies, as apothecaries do of medicines, barely by the qualities and proportions of the ingredients, ſeem to act as one who ſhould pretend to give an account of the phenomena and operations of clocks and watches, from the predominancy of the metals that make their parts, and not from their ſtructure and contrivance.

And frequently contradicts the phenomena of nature.

The next defect I obſerve in the chymical doctrine of qualities, is, that in many caſes it agrees not with the phenomena of nature. For there are ſeveral changes of qualities, wherein one may well expect, that a chymical principle ſhould have a great ſhare, and yet it does not appear to have any. He who conſiders what great operations many chymiſts aſcribe to this or that hypoſtatical principle, and how many qualities, according to them, muſt from thence be derived, cannot but expect, that a great change, as to thoſe qualities, happening in a mix'd body, ſhould, at leaſt, be accompany'd with ſome notable action of, or alteration in the principle; yet I have met with many inſtances, wherein qualities are produced, or aboliſhed, or very much altered, without any manifeſt introduction, expulſion, or conſiderable change of the principle, whereon that quality is ſaid to depend. Thus, for inſtance, a piece of fine ſilver, having been neal'd in the fire, and ſuffer'd to cool leiſurely, is very flexible; but may be made ſtiff and hard, barely by a few ſtrokes of a hammer. There is, alſo, another ſort of phenomena, which oppoſes the chymical doctrine about qualities, conſiſting of thoſe, wherein either that does not happen, which, according to their hypotheſis, ought to happen, or the contrary to what, upon their principles, might juſtly be expected. For inſtance, 'tis known to thoſe who work much in ſilver and copper, that the former will become red-hot in the fire, before it is brought to fuſion; and that the latter is yet far more difficult to be melted down than the other; yet if you ſeparately diſſolve thoſe two metals in *Aqua fortis*, and by evaporation, reduce them to cryſtals; theſe will be brought to fuſe in a very little time, and with a moderate heat in glaſſes. Aſk a vulgar chymiſt, the cauſe of this facility of fuſion, and he will probably tell you, that 'tis from the ſaline parts of the *Aqua fortis*, which, imbodied in the metals, and being of a very fuſible nature, impart that eaſineſs of fuſion thereto. Now from this plauſible explanation one might well expect, that if the ſaline corpuſcles were exquiſitely mixed with tin, they would make it far more fuſible than of it ſelf it is; yet when I put tin into a convenient quantity of *Aqua fortis*, the metal being corroded, ſubſided, as is uſual, in the form of whites of eggs, which being well dried, the tin was ſo far from growing more fuſible, that it would long endure not only a thorow ignition, but the blaſt of a pair of double bellows, without being at all brought to melt. And as for thoſe chymiſts who admit, that all kinds of metals may be turned into gold, by a very ſmall proportion of the elixir; they muſt allow from their own conceſſions, that ſeveral qualities may be changed, even in metals, without the addition of any conſiderable proportion of the ſimple ingredients, to which they aſcribe thoſe qualities; provided the agent be able to make a great change in the mechanical properties of the parts whereof the metal it acts upon conſiſts. Thus if we ſuppoſe a pound of ſilver, a pound of lead, and a pound of iron, to be tranſmuted into gold, each by a grain of the powder of projection; this powder, as a material cauſe, is inconſiderable, by the ſmallneſs of its bulk; and as an efficient, it works differing, and even contrary effects, according to the diſpoſition wherein it finds the metal to be tranſmuted, and the changes it produces in the conſtituent texture thereof. Thus it brings quick-ſilver to be fixt, and deprives it of the fluidity it had before; it brings ſilver to be inſoluble in *Aqua fortis*, which readily diſſolved it before, and ſoluble in *Aqua regis*, which before would not touch it; and, what is very conſiderable to our preſent purpoſe, whereas it makes iron much more fuſible, it makes lead much leſs fuſible than whilſt it retained its priſtine form; ſince lead melts before it comes to ignition, which gold requires to bring it to fuſion.

But ſome modern chymiſts would be thought to explain ſeveral of the changes that happen to bodies in point of odour, colour, *&c.* by ſaying, that in ſuch alterations the ſulphur, or other hypoſtatical principle, is intraverted or extraverted; which, I confeſs, ſeem to me rather new terms, than real explanations. For it may be juſtly objected, that the ſuppoſed extraverſion or intraverſion of ſulphur can, by no means, give an account of ſo great a variety of odours, colours, and other qualities, as may be found in the changed portions of matter we are ſpeaking of. Beſides, what they call by theſe and the like names, cannot be done without local motion, tranſpoſing the particles of the matter, and, conſequently, producing in it a change of texture, which is the very thing we would infer; and which being ſuppoſed, we may grant ſulphur to be often actually preſent in the altered bodies, without allowing it to be always neceſſary to produce the alterations in them; ſince corpuſcles, ſo condition'd and arranged, would produce ſuch effects, whether ſulphur did, or did not, make the ſubject-matter of the change.

The principles found in bodies not the cauſe of their qualities.

I ſhall mention but two imperfections more that particularly relate to the doctrine of qualities.

And firſt I do not think it a convincing argument, that is employed by the *Ariſtotelians* for their elements, and by the chymiſts for their principles, that, becauſe this or that quality, which they aſcribe to an element, or a principle, is found in this or that body, which they call mixt, therefore it muſt owe that quality to the participation of that principle or element. For, the ſame texture of parts, or other modification of matter, may produce the like quality in the more ſimple and the more compound body; and they may both, ſeparately, derive it from the ſame cauſe, and not one from the participation of the other. Thus water, earth, metals, ſtones, *&c.* are heavy upon account of the common cauſe of gravity, and not becauſe the reſt partake of earth; for elementary water, as ſimple a body as that, is yet heavy: ſo oil, highly rectified ſpirit of wine, mercury, metals, glaſs of antimony, and minium, whilſt in fuſion, are fluid; being made ſo by the variouſly determined motions of their minute parts, and other cauſes of fluidity; and not by the participation of water; ſince the dry calces of lead and antimony are not likely to have retained in the fire ſo volatile a liquor as water; and ſince fluidity is a quality that mercury enjoys in a more durable manner than water it ſelf: for that metalline liquor, as alſo ſpirit of wine well rectified, will not be brought to freeze with the higheſt degree of cold of our ſharpeſt winters, tho' a far leſs degree of cold would make water ceaſe to be fluid, and turn it to ice.

Contrary qualities aſcribed to the ſame body.

And laſtly, 'tis pleaſant to ſee how arbitrarily the *Peripatetics* derive the qualities of bodies from the four elements. Thus to inſtance in liquidity, if you ſhew them exactly dephlegmed ſpirit of wine, and ask, whence it has its great fluidity, they will tell you, from water; which yet is far leſs fluid than it; and ſpirit of wine it ſelf is much leſs ſo than the flame into which that ſpirit is eaſily excited. But if you ask, whence it becomes totally inflammable, they muſt tell you, from the fire; and yet the whole body, at leaſt as far as ſenſe can diſcover, is fluid, and becomes flame; ſo that fire and water, as contrary as they make them, muſt both be vaſtly predominant in the ſame body. This ſpirit of wine, alſo, being a liquor, whoſe leaſt ſenſible parts are actually heavy, and compoſe a liquor ſeven or eight hundred times as heavy as air of the ſame bulk, muſt be ſuppoſed to abound with earthy particles; and yet this ſpirituous liquor may, in a trice, become flame, which they would have to be the lighteſt body in the world.

Upon the whole, the chymiſt's ſalt, ſulphur, and mercury themſelves, are not the firſt and moſt ſimple principles of bodies, but rather primary concretions of corpuſcles or particles more ſimple than they; as being endowed only with the firſt moſt radical, and moſt univerſal properties of ſimple bodies, bulk, ſhape, motion, or reſt; by the different conventions or coalitions of which minuteſt portions of matter, are made thoſe differing concretions that chymiſts call their principles.

SECT. II.

Reflections upon the hypotheſis of alkali and acid.

I Preſume, it will not be difficult to diſcern, that a great part of what has been alledg'd to ſhew the imperfection of the vulgar chymical doctrine of qualities, may eaſily be applied to ſome other hypotheſes of kin to that doctrine, and particularly to the theory that would derive both the qualities of bodies, and the reſt of the phenomena of nature, from acid and alkali. For tho' theſe two differences may be met with in a great variety of bodies, and conſequently the conſideration of them will frequently be of good uſe to chymiſts, in conſidering the ſecondary cauſes and operations of ſome mixt bodies; yet I cannot allow of the hypotheſis in the latitude wherein 'tis urged and applied, as if it could be uſefully ſubſtituted in the place of matter and motion *.

The ſuppoſition of them precarious.

For it ſeems precarious to affirm, that acid and alkaline parts are found in all bodies.

Some chymiſts, when they ſee *Aqua fortis* diſſolve filings of copper, conclude from thence, that the acid ſpirits of the menſtruum meet, in the metal, with an alkali, upon which they work; † but this is an un-

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* "Since, " ſays M. *Homberg*, " the " doctrine of alkali and acid has been " advanced, 'tis made uſe of to explain " all the changes that happen in the " mixtures of ſimples, particularly in the " effects of fermentation, effervescence, " and ebullition. But there is ſcarce " any fermentation produced by the " mixture of acid and alkali; and even " ebullitions and effervescences often proceed from other cauſes." See *French Memoirs*, *A.* 1701. *p.* 146.

† M. *Homberg* is of opinion, that all acid ſpirits diſſolve bodies, by means of the ſalt which ſuch ſpirits contain; and to diſcover their quantity of pure acid ſalts, he ſuffers an ounce of ſalt of tartar to ſaturate it ſelf with the ſpirit; then evaporating all the moiſture, the ſalt of tartar remains increaſed by the weight of the acid ſalts.

By this means he made the following table.

		oz.	*dr.*	*gr.*		*dr.*	*gr.*		*dr.*	*gr.*
An ounce of ſalt of tartar took up of	Spirit of nitre	01	02	36	And gained after evaporation	03	10	Whence an ounce of the liquor contain'd of volatile acid ſalt	02	28
	— of ſalt	02	05	00		03	14		01	15
	Oil of vitriol	00	05	00		03	05		04	65
	Aqua fortis	01	02	30		03	06		02	26
	Diſtill'd vinegar	14	00	00		03	36		00	18

Fig. 5.

He, likewiſe, uſes an inſtrument, or aræometer, made of a ſmall glaſs matras, with a neck, AD, ſo ſlender, that a ſingle drop of water will riſe about half an inch in it. On the ſide of this neck there comes from the belly B, of the veſſel, a ſmall tube C, of the ſame ſize with the neck, and parallel to it, above half an inch long. This little tube lets the air paſs out of the veſſel, as the liquor comes in. A mark D, is put upon the neck AD, to ſhew how high the veſſel muſt be filled. And 'tis proper to let the neck widen towards the top, for the conveniency of pouring in

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unſafe way of arguing, ſince good ſpirit of urine, which they take to be a volatile alkali, and which makes a great conflict with *Aqua fortis*, will readily diſſolve filings of copper, and more genuinely than the acid liquor. So when they ſee the magiſtery of pearl or coral, prepared by dropping oil of tartar into the ſolutions of thoſe bodies, made with ſpirit of vinegar, they aſcribe the precipitation to the fixt alkali of the tartar, that mortifies the acidity of the ſpirit of vinegar; whereas the precipitation would no leſs enſue, if, inſtead of the alkalizate oil of tartar, that ſtrong acid, *Oleum ſulphuris per campanam*, were employ'd.

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in the liquor. Now this inſtrument being fill'd to the mark on its neck, with any acid ſpirit, the balance will ſhew the weight of the liquor, in reſpect of any other, to the fifth part of a drop. Hence this ingenious gentleman has made a table, to ſhew the different weights of the ſame bulk of the moſt conſiderable chymical liquors, in the ſummer and in winter.

The Aræometer full of	Weigh'd in ſummer.			In winter.		
	oz.	*dr.*	*gr.*	*oz.*	*dr.*	*gr.*
Quick-ſilver	11	00	07	11	00	32
Oil of tartar	01	03	08	01	03	31
Spirit of urine	01	00	32	01	00	43
Oil of vitriol	01	03	58	01	04	03
Spirit of nitre	01	01	40	01	01	70
—— of ſalt	01	00	39	01	00	47
Aqua fortis	01	01	38	01	01	55
Diſtill'd vinegar	00	07	55	00	07	60
Spirit of wine	00	06	47	00	06	61
River-water	00	07	53	00	07	57
Diſtill'd water	00	07	50	00	07	54

The inſtrument it ſelf weighed, when empty, one dram twenty-eight grains.

From theſe two tables, compared together, 'tis eaſy to determine, with great exactneſs, the quantity of ſalt and of phlegm contain'd in an acid ſpirit. See *Memoirs de l'Acad. A.* 1669. *p.* 69.

To meaſure the force of an alkali, that is, to eſtimate how much of an acid 'tis able to retain, the ſame gentleman proceeds in this manner. He diſſolves the alkali in ſome acid ſpirit, whoſe force is firſt diſcovered by means of his aræometer; comparing its weight with that of river-water. Thus having dephlegmed ſome ſpirit of nitre, and of ſalt, till the former perfectly diſſolved gold, and the latter ſilver, he found the weight of the ſpirit of nitre to be, in an equal bulk, as 19, that of the ſpirit of ſalt as 17, and that of water as 16. He put an ounce of each ſpirit upon crabs-eyes, coral, pearl, bezoar, oyſter-ſhells, *&c.* of which they diſſolved different quantities; the ſpirit of nitre taking up twice as much of ſome of them as the ſpirit of ſalt; and in general, the former diſſolved a conſiderable quantity more than the latter; the proportion of its ſalt being almoſt double to that of the other. Now the different quantity of each alkali neceſſary to abſorb the ſame quantity of a ſtandard acid, is, according to M. *Homberg*, the meaſure of the paſſive force of that alkali; notice being taken of the time ſpent in the diſſolution. This author farther obſerved, that both the ſpirits readily diſſolved much more of the oyſter-ſhells than of any other powder of the like nature; which he takes to be one reaſon of the very good effect they have in the ſtomach, depraved by acids. *Memoir de l'Acad. A.* 1700. *p.* 81. and *Hiſt. de l'Acad. A.* 1700. *p.* 63.

It alſo may be doubted, whether the vulgar chymiſts juſtly ſuppoſe, that when they manifeſtly diſcover an acid, for inſtance, in a body, the operation of that body upon another, which they judge to abound with an alkali, muſt be the effect of a conflict between thoſe two principles. For an acid body may do many things, not ſimply as an acid, but on account of a texture or modification, which endows it with other qualities as well as acidity. Thus when ſome chymiſts ſee an acid menſtruum, as *Aqua fortis*, ſpirit of ſalt, oil of vitriol, *&c.* diſſolve iron, they preſently aſcribe the effect to an acidity in the liquors; tho' well dephlegmed urinous ſpirits, which they hold to have a great antipathy to acids, will, as I have tried in ſome of them, readily diſſolve crude iron, even in the cold. But mercury will not work on the filings of iron, tho' this be ſo open a metal, that even weak liquors will do it; yet if one ſhould urge, that quick-ſilver readily diſſolves gold in amalgamation, he may expect to be told, according to their doctrine, that mercury has in it an occult acid, by which it performs the ſolution; tho' it ſeems much more probable, that mercury has corpuſcles of ſuch a ſhape and ſize as fit them to inſinuate into the correſpondent pores they meet with in gold, but render them unfit to enter readily the pores of iron, to which nature has not made them ſuitable: as on the other ſide, the ſaline corpuſcles of *Aqua fortis* will eaſily find admiſſion into the pores of iron, but not into thoſe of gold, to which they do not correſpond. And when a knife, whoſe blade is touched with a load-ſtone, cuts bread, and takes up filings of iron, it does neither by means of alkali or acid; but the one by the viſible ſhape and the ſtiffneſs of the blade, and the other by the latent contrivance or change of texture, produced by the operation of the load-ſtone in the particles of the ſteel.

And thus too, when blue vitriol, being beaten and finely ſearced, makes a white powder, that whiteneſs is not a quality of the powder, as being of a vitriolate nature; for rock-cryſtal, or *Venice* glaſs, finely beaten, will have the ſame effect on the eye; but it proceeds from the tranſparency of the body, and the minuteneſs, multitude and confus'd ſituation of the corpuſcles that make up the powder. And, therefore, if other bodies be brought, by comminution, into parts of the like mechanical properties; theſe aggregates will act upon the organ of ſight as white bodies.

Their offices arbitrary.

Further, the patrons of this hypotheſis ſeem arbitrarily to have aſſigned offices to each of their two principles, as the chymiſts do to each of their *tria prima*, and the *Peripatetics* to each of their four elements. But 'tis not enough to ſay, that an acid, for inſtance, performs theſe things, and an alkali thoſe; and that they divide the operations and phenomena of natural bodies between them: aſſertions of ſuch great moment ought not to be advanced, or received, without ſufficient proof. And, perhaps, the very diſtribution of ſalts into acids and alkalies hath ſomewhat of arbitrary in it; ſince others may, with-

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out aſſuming much more, take the freedom to diſtribute them otherwiſe; there being not only ſeveral things wherein acids and alkalies agree, but alſo ſeveral things wherein ſalts of the ſame denomination widely differ. For inſtance, ſome alkalies, according to our chymiſts, are, like ſalt of tartar, fixt, and will endure the violence of the fire; others, like ſalt of urine or hartſhorn, are exceedingly fugitive, and will be driven up with a ſcarce ſenſible degree of heat; ſome, as ſalt of tartar, will precipitate the ſolution of ſublimate into an orange-tawny; others, as ſpirit of blood and hartſhorn, precipitate ſuch a ſolution into a milky ſubſtance; and oil of tartar very ſlowly operates upon filings of copper, which ſpirit of urine and hartſhorn will readily diſſolve in the fire.

And among acids themſelves the difference is no leſs; for ſome of them will diſſolve bodies that others will not, as *Aqua fortis* diſſolves ſilver and mercury, but leaves gold untouch'd; *Aqua regis*, that diſſolves gold readily, diſſolves mercury but imperfectly, and ſilver not at all. And this may happen, when the menſtruum, that will not diſſolve the body, is reputed much ſtronger than that which does; as dephlegmed ſpirit of vinegar will diſſolve lead, reduc'd to minute parts, in the cold; which is an effect that chymiſts expect not from ſpirit of ſalt. Nay, one acid will precipitate what another has diſſolved, and *è contrà*; as ſpirit of ſalt will precipitate ſilver out of ſpirit of nitre. And I found oil of vitriol to precipitate bodies of various kinds, minerals, and others, out of ſome acid menſtrua, particularly ſpirit of vinegar.

We might add the properties peculiar to ſome particular acids, as that ſpirit of nitre, or *Aqua fortis*, will diſſolve camphire into an oil, and coagulate common oil into a conſiſtent and brittle ſubſtance, like tallow; and tho' it will both corrode ſilver, copper, lead, and mercury, and keep them diſſolved, it quickly lets fall almoſt the whole body of tin, very ſoon after having corroded as much as it can thereof. Hence we may very well queſtion, whether acid and alkali have the ſimplicity that philoſophy requires in principles. Nor will it be any wonder if others ſhall think it as free for them to conſtitute other principles, as 'tis for chymiſts to pitch upon acid and alkali.

And ſome, perhaps, will ſay, that, ſince the former of theſe principles comprehends ſuch a number of very different bodies, it ſeems as ſlight and unphiloſophical an account of their nature, to define an acid by its hoſtility to an alkali, as to define a man by ſaying, that he is an animal at enmity with the ſerpent.

And the notion of them unſettled.

But tho' one of the chief conditions that philoſophers juſtly require in principles, is, that they ſhould be very clear; yet I do not wonder, that the definitions given us of acid and alkali ſhould be inaccurate and ſuperficial; ſince I find not, that chymiſts themſelves have any clear and determinate notion or ſure marks, whereby to know them diſtinctly. For to infer, as is uſual, that, becauſe a body diſſolves another, which is diſſoluble by this or that known acid, the ſolvent muſt alſo be acid; or to conclude, that if a body precipitates a diſſolved metal out of a confeſſedly acid menſtruum, the precipitant muſt be an alkali, is precarious; ſince filings of ſpelter will be diſſolved as well by ſome alkalies, *viz.* ſpirit of ſal-armoniac, *&c.* as by acids: and bodies may be precipitated out of acid menſtrua, by other acids, and by liquors wherein there appears not the leaſt alkali. I have found, that a ſolution of tin-glaſs, made in *Aqua fortis*, would be precipitated both by ſpirit of ſalt, and by common or rain-water. And as for the other grand way that chymiſts employ, to diſtinguiſh acids and alkalies, by the heat, commotion, and bubbles that are excited, upon their being put together; this may be no ſuch certain ſign as they preſume: for almoſt any thing that is fitted variouſly and vehemently to agitate the minute parts of a body, will produce heat in it; and ſo, tho' water be neither an acid nor an alkalizate liquor, yet it will quickly grow very hot, not only with the highly acid oil of vitriol, but with the alkalizate ſalt of tartar: yet in neither of theſe mixtures is there produced any ſuch viſible or audible conflict, as, according to the doctrine of the chymiſts, one would expect. Neither is the production of bubbles, tho' accompanied with a hiſſing noiſe, ſuch a certain ſign as chymiſts imagine: for the production of bubbles is not a neceſſary effect or concomitant of heat, excited by conflict; but depends very much upon the peculiar diſpoſition of bodies, put together, to extricate, produce, or intercept particles of air; and therefore, as oil of vitriol, mixt in a due proportion with fair water, may be brought to make the water very hot, without exciting bubbles; ſo I have found that alkalizate ſpirit of urine, drawn with ſome kinds of quick-lime, being mixt with oil of vitriol moderately ſtrong, would afford an intenſe heat, whilſt it produced either no manifeſt bubbles at all, or ſcarce any; tho' the urinous ſpirit was ſtrong, and in other trials operated like an alkali; and tho' with ſpirit of urine, made *per ſe*, in the common way, oil of vitriol will produce a great hiſſing, and a multitude of conſpicuous bubbles. On the other ſide, I have, ſometimes, found, that ſome acid ſpirits, eſpecially that of verdigreaſe, made *per ſe*, would, when poured upon ſalt of tartar, make a conflict with it, and produce a large froth; tho' we obſerved it not to be accompanied with any manifeſt heat.

The taſt no judge of alkalies and acids.

The taſt, by many, is made the touch-ſtone whereby to try acids and alkalies. But there is a multitude of mixt bodies, wherein we can ſo little diſcern by the taſt, which of the principles is predominant, that this would not make one ſuſpect there were a grain of either of them to be found therein; ſuch bodies are diamonds, rubies, and moſt gems, beſides many ignobler ſtones, gold, ſilver, mercury, *&c.* There are alſo bodies that abound with acid or alkalizate ſalts, which either have no taſt, or a quite different one from that of the

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chymical principles. Thus, tho' *Venice* glaſs be in great part compoſed of a fixt alkali; yet it is inſipid upon the palat: and cryſtals of ſilver, and of lead, made with *Aqua fortis*, and containing numerous acid particles of the menſtruum, manifeſt nothing of acidity in the mouth; the latter having a ſaccharine ſweetneſs, and the former an extream bitterneſs. And even in vegetable ſubſtances of a manifeſt taſt, 'tis not eaſy to know by that, whether it be the acid or the alkalizate principle which rules in them; as in the eſſential oils of ſpices and other vegetables, and in the groſs empyreumatical oils of woods, and even in high rectified ſpirit of wine, which, therefore, ſome will have to be an alkalizate liquor, and others an acid, tho' I did not find its taſt to be deſtroyed or much altered by being put upon coral or ſalt of tartar, nor by being digeſted with and diſtill'd from ſea-ſalt. And among thoſe very bodies which, for their taſts, chymiſts reckon among acids, there is ſo great a difference and variety of reliſhes, that, if I were to allow acids to be one principle, it ſhould be as I allow air to be one body, whilſt it conſiſts of the aſſociated effluvia of a multitude of corpuſcles of very differing natures.*

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* At once to eſtabliſh a juſt notion, to explain the nature, the manner of action, and the force of acids, take the words of the illuſtrious Sir *Iſaac Newton* upon the ſubject.

" The particles of acids, " ſays that great philoſopher, " are of a ſize groſſer than thoſe of water, and therefore leſs volatile; but much ſmaller than thoſe of earth, and therefore much leſs fix'd than they. They are endued with a great attractive force; in which force their activity conſiſts; and thereby alſo they affect and ſtimulate the organ of taſt, and diſſolve ſuch bodies as they come at. They are of a middle nature between water and terreſtrial bodies, and attract the particles of both. By this attractive force they get about the particles of bodies, whether they be of a metalline or ſtony nature, and adhere to them moſt cloſely on all ſides; ſo that they can ſcarce be ſeparated from them by diſtillation, or ſublimation. When they are attracted and gathered together about the particles of bodies, they raiſe, disjoin, and ſhake them one from another; that is, they diſſolve thoſe bodies. By their attractive force, alſo, by which they ruſh towards the particles of bodies, they move the fluid, excite heat, and ſhake aſunder ſome particles, ſo as to turn them into air, and generate bubbles; and hence proceeds diſſolution, and all violent fermentation: and in all fermentation there is an acid latent or ſuppreſs'd, which coagulates in precipitation. Acids, alſo, by attracting water, as much as they do the particles of bodies, occaſion the diſſolved particles readily to mix with water, or ſwim, or float in it, after the manner of ſalts. And as this globe of earth, by the force of gravity, attracting water more ſtrongly than lighter bodies, cauſes thoſe lighter bodies to aſcend in the water, and to go upwards from the earth; ſo the particles of ſalts, by attracting the water, mutually avoid and recede from one another as far as they can, and thence are diffus'd throughout the whole water. The particles of *Sal alkali* conſiſt of earth and acid united together, after the ſame manner: but theſe acids have ſo great an attractive force, that they can't be ſeparated from the ſalts by fire. They alſo precipitate the particles of metals diſſolv'd in menſtrua, by attracting from them the acid particles, which before had diſſolved them, and kept them ſuſpended in the menſtruum. If theſe acid particles be join'd with

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Another particular wherewith I am unſatisfied in the hypotheſis of acid and alkali, is, that 'tis in many caſes needleſs to explain the

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"earthy ones, in a ſmall quantity, they are ſo cloſely retained by them, as to be quite ſuppreſs'd, and, as it were, hidden by them; ſo that they neither ſtimulate the organ of ſenſe, nor attract water, but compoſe bodies which are not acid, that is, fat and fuſible bodies, ſuch as are *Mercurius dulcis*, brimſtone, *Luna cornea*, and copper corroded by mercury ſublimate. From the attractive force in theſe acid particles thus ſuppreſs'd, ariſes that univerſal property of almoſt all fat bodies, that they adhere or ſtick to others, and are eaſily inflammable, if the heated acid particles meet with other particles of bodies in fume, which the acid attracts more ſtrongly than it doth the particles to which it is united. And thus the acid that lies ſuppreſs'd in ſulphureous bodies, by more ſtrongly attracting the particles of other bodies (earthy ones for inſtance) than its own, promotes a gentle fermentation, produces and cheriſhes natural heat, and carries it on ſometimes, as the putrefaction of the compound: which putrefaction ariſes hence, that the acid particles, which have a long while kept up the fermentation, at length inſinuate themſelves into the little interſtices, that lie between the particles of the firſt compoſition; and ſo, intimately uniting with thoſe very particles, produce a new mixture or compound, which cannot fall back again into the ſame form.

"Nitre in diſtillation, leaving its earthy part behind, turns, moſt of it, into an acid ſpirit; becauſe the acid of the nitre attracts the phlegm, and, therefore, they aſcend together, and conſtitute a ſpirit. But nitre kindled with a coal, turns chiefly into a ſalt of tartar; becauſe the fire apply'd this way, drives the acid and earthy parts together, and makes them impinge on, and more ſtrongly unite one with another. The reaſon why water hath no great diſſolving force, is, becauſe there is but a ſmall quantity of acid in it: for whatever ſtrongly attracts, and is ſtrongly attracted, may be called an acid; and in ſuch things as are diſſolv'd in water, we ſee the diſſolution is eaſily perform'd, and without any efferveſcence: but where the attraction is ſtrong, and the particles of the menſtruum are every way attracted by thoſe of the metal; or rather, where the particles of the metal are every way attracted by thoſe of the menſtruum; there the particles of the menſtruum environ thoſe of the metal, tear them aſunder, and diſſolve its texture. So when theſe acid particles are applied to the tongue, or to any excoriated part of the body; leaving the ſubtile earth in which they were before, they ruſh into the liquid of the organ, tear and disjoin its parts, and cauſe a painful ſenſation.

"Mercury is attracted, and, therefore, corroded by acids; and as it opens obſtructions by its great weight, ſo it breaks and obtunds the power of acids, in the body, by its attractive force.

"All bodies have particles which mutually attract one another; the aggregates of the leaſt of which may be called particles of the firſt compoſition; and the collections, or aggregates, ariſing from the primary aggregates, or the aggregates of theſe aggregates may be called particles of the ſecond compoſition, &c.

"Mercury and *Aqua regia*, pervade thoſe pores of gold or tin, which lie between the particles of its laſt compoſition; but they can get no further into it; for if any menſtruum could do that, or if the particles of the firſt, or, perhaps, of the ſecond compoſition of gold, could be ſeparated, that metal might be made fluid, or at leaſt more ſoft. And if gold could be once brought to ferment and putrefie, it might be turned into any other body whatſoever; and ſo of tin, or any other bodies; as common nouriſhment is turned into the bodies of animals and vegetables." *Newton. apud Harris. Lexicon Technic.*

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The hypotheſis of them often needleſs and inſufficient.

phenomena of qualities; ſeveral of theſe being produced, deſtroyed, or altered, where there does not appear any acceſs, receſs, or change of either of thoſe two principles; as when fluid water, by beating, is turn'd into conſiſtent froth; and when tranſparent red coral is, barely by grinding, changed into a white and opake powder.

Beſides, the patrons of acid and alkali, tho' they would ſeem to conſtitute but two principles, are obliged to make many different ſorts of acids, and ſome variety of alkalies; and ſtill their principles are too ſcanty to afford any ſatisfactory explanation of phenomena. 'Twill be very difficult for them to give a rational account of gravity, elaſticity, light, colours, ſounds, and ſome other qualities that are called manifeſt; and much more of ſeveral that are confeſſedly occult, as electricity, and magnetiſm: and this ſhews a great inſufficiency in the hypotheſis.

Affording but unſatisfactory ſolutions of phenomena.

The laſt defect I ſhall mention in the doctrine of alkali and acid is, that moſt of thoſe very things which are pretended to be explained by it, are not ſatisfactorily explained.

I am diſſatisfied with the very fundamental notion of this hypotheſis, a ſuppoſed hoſtility between the tribe of acids and that of alkalies: for I look upon amity and enmity as affections of intelligent Beings; and I have not yet found it explained by any, how thoſe appetites can be placed in bodies inanimate, and deſtitute of knowledge and ſenſe. And what is called ſympathy and antipathy between ſuch bodies, in great meaſure depends upon the action of our own underſtanding, which, ſuppoſing in every body an innate appetite to preſerve it ſelf, both in a defenſive and an offenſive way, inclines us to conclude, that a body, which deſtroys, or impairs, the ſtate or texture of another, has an enmity to it; tho', perhaps, a ſlight mechanical change may make bodies, that ſeem extreamly hoſtile, appear to agree very well, and co-operate to the production of the ſame effects. Thus, if the acid ſpirit of ſalt, and the volatile alkali, commonly called ſpirit of urine, be put together, they will, after a fierce conflict, unite together upon a new contexture, into a ſalt, little differing from ſal-armoniac; in which the two reconciled principles amicably join in cooling water, diſſolving ſome metalline bodies, and producing ſeveral other effects. And ſo, if upon a ſtrong ſolution of ſalt of pot-aſhes, or of ſalt of tartar, good ſpirit of nitre be dropt in a due proportion; after the heat, tumult, and ebullition are over, the acid and the alkalizate ſalts will convene into ſuch a concretion as ſalt-petre; which is taken to be a natural body, either homogeneous, or at leaſt conſiſting of parts that agree very friendly together, and conſpire to conſtitute the particular kind of ſalt that chymiſts call nitre.

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Again; the explanations given of phenomena, according to the doctrine of alkali and acid, do not perform what may be juſtly expected from philoſophical ſolutions. 'Tis ſaid, indeed, that the acid working on the alkali, or this upon that, produces the effect propoſed; but this is only to tell us, what is the agent that operates, and not the manner of the operation, or the means and proceſs whereby it produces the effect. And if it be ſaid, that it is by the mutual hoſtility of the principles, that the effect is produced, it may be anſwered, that this hoſtility it ſelf is not, as we have juſt now obſerved, a thing clear, if ſo much as intelligible; and were it, yet ſo general and indeterminate a way of explaining things, can afford little or no ſatisfaction to one who conſiders how very numerous and various the phenomena of qualities are.

To clear and confirm this aſſertion, I ſhall only take notice of ſome few obvious phenomena of one of the moſt familiar operations, wherein acid and alkali are ſuppoſed to be the grand agents. 'Tis a known thing, that *Aqua regis* will diſſolve gold, copper, and mercury; and that with theſe metals, eſpecially with the ſecond, it will produce an intenſe degree of heat. If now the cauſe of this heat be demanded, it may be expected, that the patrons of acid and alkali will anſwer, that 'tis from the action of the acid ſalts of the menſtruum upon the alkali they meet with in the metals. But it is eaſy to diſcern, that this anſwer names, indeed, two ſuppoſed efficients of heat, but does not declare how theſe agents produce that quality; which depends upon a certain, vehement, and various agitation of the inſenſible parts of bodies. And, therefore, gold and copper, by bare concuſſion, may be brought to an intenſe degree of heat, without the acceſſion of any acid particles to work upon them. But, further, when I am told, that *Aqua regis*, by its acidity working on the metalline alkali, makes a diſſolution of the metal; I am told, indeed, what they think to be the agent in this change, but not at all ſatisfied how this agent effects it; for, copper being a very hard metal, and gold generally eſteemed, by chymiſts, the cloſeſt and compacteſt body in nature, I would gladly know, by what power ſuch weak, and, probably, brittle or flexible bodies, as acid ſalts, are enabled with that force to disjoin ſuch ſolid, and cloſely coherent corpuſcles, as make up the viſible maſſes of copper and gold; and ſhatter them with that violence, as, perhaps, to toſs up multitudes of them into the air. And ſince in the diſſolution of theſe metals, there is another phenomenon to be accounted for, as well as the forcing of the parts aſunder; the ſuſtentation of the metal in the menſtruum; the chymiſts would greatly inform me, by well explaining how their acid and alkali are able to ſuſtain, and give fluidity to the corpuſcles of the diſſolved metal; which, tho' it be but copper, is nine times as heavy as an equal bulk of water; and if it be gold, is nineteen times heavier than the liquor that muſt ſuſtain it; and, at leaſt, ſeveral times heavier *in ſpecie* than the ſalts that are mixed with the aqueous parts, can make the menſtruum compoſed of them both: at the ſame time, experience has aſſured me, that if a piece of wax, or any like matter, be made leſs than the hundredth part heavier than an equal bulk of water, it will, when thoroughly immerſed, fall to the bottom, and reſt there. I might further ask, why, as *Aqua regis* diſſolves mercury, without being much changed in colour by it, gold retains its own yellowneſs in the ſolvent; and why the ſolution of copper is of a colour quite different from that of the metal which affords it, and from that of the ſolvent? In ſhort, thoſe hypotheſes greatly hinder the progreſs of human knowledge, that introduce morals and politics into philoſophy, where all things are tranſacted according to mechanical laws.

MEDICINE.

The PREFACE.

WE have now traced Mr. Boyle *to the laſt ſtage of his philoſophical works, that of medicine. And, as I doubt not, he has hitherto ſhew'd himſelf a much greater philoſopher than the world, for want of a thorow knowledge of his writings, ever eſteem'd him; ſo, here he appears a much greater phyſician than he generally ſeems to have paſſed for.*

'Tis true, in ſhewing, by way of introduction, the uſefulneſs of philoſophy to medicine, he manifeſted an uncommon skill in diſeaſes, and the human ſtructure; but, I know not how, his philoſophic capacity appears to ſwallow up his medicinal one, till we come to conſider him ſtrictly as a phyſician; and then he ſhews a maſterly genius, and a very wide command in medicine. But never actually taking the profeſſion upon him, and, conſequently, often wanting the proper opportunities of ſeeing the ſucceſs of remedies applied in particular caſes, he was generally obliged to make his medicinal experiments by other hands. And if we may judge from what appears, thoſe perſons to whom he committed any of his medicines with this view, were ſeldom ſo uncourtly as to bring him an account of their failure; but when the wiſh'd ſucceſs attended their exhibition, he was ſure to be told it in the moſt obliging manner. And hence, to omit other things, it poſſibly is, that Mr. Boyle *recommends* Ens veneris, *as a ſpecific for the rickets; which, tho' a ſerviceable medicine, when rightly tim'd in this diſeaſe, ſeldom, of it ſelf, performs the cure.*

On the other hand, our author was well aware of the accidents and uncertainties which daily occur in practice. He tells us expreſly, that he does not ſet down medicinal experiments with the ſame poſitiveneſs he does thoſe in philoſophy; nor venture his reputation upon the ſucceſs of any receit or proceſs in medicine. Theſe, however, "ſays he, "I always deliver faithfully; nor have I, upon uncertain rumours, recorded the virtues of particular remedies, which may be good, without being infallible." We may take him, then, upon the whole, as *a phyſician; for he, doubtleſs, makes good the character: and, had it been his fortune to have practiſed the art, he would, I queſtion not, have improved it ſtill more than he has. He had a ſtrange ſagacity in diſcovering the origin of diſeaſes; he appears to have thoroughly conſidered their manner of acting upon the human frame; and to have hit upon the method of curing them by very plain and ſimple medicines: witneſs the piece which concludes this laſt general head of our abridgment.*

There are ſome, indeed, who have thought fit to cenſure that admirable collection of remedies, as worthleſs: and truly we ſhould have been obliged to them, if they had furniſh'd the world with a better: but till this is done, which, I am afraid, it will not ſoon be, we are to conſider, that our author's view was here to offer the generality, and ſuch who live at a diſtance from phyſicians, a ſet of remedies, which might ſoon, with little trouble, and great cheapneſs, be prepared, as occaſion required. And will any man ſay, that the book does not anſwer this deſign? Where, then, lies the cauſe of blame? The remedies, cries one, are ſimple, ſuch as the good women preſcribe, and ſome of them appear ridiculous. But we are to know, that Mr. Boyle, *if the nature of his deſign had required it, cou'd have preſcribed as elegant compounds as any phyſician who has wrote; but of ſuch he had, for weighty reaſons, no great opinion; and theſe ſimple ones anſwer his end much better than the other. The remedies contain'd in this collection too, had been long experienced, and found effectual, before he communicated them to the public.*

'Tis, we muſt own, a difficult thing to ſet down a large number of ſimple, ſerviceable, and experienc'd remedies, and keep them from appearing ridiculous to ſuch as have ſeen little in phyſic; but the men of experience and of judgment in the art, who know how ſlight and how unpromiſing a remedy ſometimes, apparently, performs great cures; and how powerful and experienc'd ones ſometimes fail, are not forward to cenſure a medicine for appearing contemptible, eſpecially after it has been tried, and found effectual.

In ſhort, whoever publiſhes a collection of remedies, well adapted to the occaſion, approved by experience, eaſy to be procured, and cheap in the purchaſe, all which recommendations go along with theſe of Mr. Boyle, *cannot but deſerve well of mankind.*

ME-

MEMOIRS

FOR THE

NATURAL HISTORY

OF

Extravaſated human Blood, eſpecially its ſpirit.

Heads for the natural hiſtory of human blood, in an healthy ſtate.

1. *THE colours of human blood, arterial and venal.*
2. *Its taſt.*
3. *Its odour.*
4. *Its heat when freſh emitted.*
5. *Its inflammability, and ſome other qualities.*
6. *The aerial particles naturally mix'd with human blood; and alſo found in its diſtinct parts.*
7. *The ſpecific gravity of human blood entire.*
8. *The ſpecific gravity of the two obvious parts of human blood, the red and ſerous.*
9. *The conſiſtence of entire human blood.*
10. *The diſpoſition of it to concrete, and the time wherein it is performed.*
11. *The liquors and ſalts that coagulate human blood.*
12. *The liquors and ſalts that hinder its coagulation, or diſſolve it when coagulated.*
13. *The liquors,* &c. *that preſerve human blood.*
14. *The mixtures it may admit from aliments.*
15. *Its ſpontaneous or natural analyſis, into a ſerous and a fibrous part.*
16. *The reſpective quantities of the ſerous and fibrous parts.*
17. *The differences between the ſerous and the red part.*

18. *The artificial or chymical analyſis of human blood; and firſt of its ſpirit.*
19. *The volatile ſalt of human blood, and its figures.*
20. *The phlegm of diſtilled human blood.*
21. *The two oils of human blood.*
22. *Its fixt ſalt.*
23. Terra Damnata.
24. *The proportion of the differing ſubſtances, chymically obtained from human blood.*
25. *The fermentation or putrefaction of human blood, and its phenomena.*
26. *The mechanical uſes of human blood, as in huſbandry,* &c.
27. *The chymical uſes of it.*
28. *The medicinal uſes of human blood.*
29. *The difference between human blood in ſound perſons of different conſtitutions, and in different circumſtances, as men, women, children,* Moors, Negroes, *&c.*
30. *The affinity and difference between the blood of men and that of other animals, as quadrupeds, birds, fiſhes, and ſanguineous inſects.*
31. *Particulars omitted, relating to the hiſtory of human blood.*
32. *Miſcellaneous obſervations, experiments, and inquiries about human blood.*

SECT. I.

The heat of human blood, newly extravaſated.

I Have learnt by inquiry, that ſeveral perſons, free from a fever, have, after their blood had run out a while, upon phlebotomy, complain'd, they found it come ſenſibly hotter than before; and ſome, that it came with a degree of heat that was troubleſome, and, as they fancied, ready to ſcald them.

I deſired a chirurgeon, to put a ſealed weather-glaſs into the porringer, wherein he was going to bleed a young gentlewoman, ſo that as the blood ran out of the open vein, it might fall upon the ball of the inſtrument; in which the liquor was made, by the warmth, to aſcend about an inch.

But having procured a man of a middle age, who ſeemed healthy, to bleed in the ſame manner, upon the ſame weather-glaſs; the ſpirit of wine aſcended above all the marks belonging to the ſtem, and ex-

expanded it ſelf conſiderably in the ſmall upper ball; ſo that tho' we could not determine how high it would have riſen, if the ſtem had been long enough, yet it ſeem'd manifeſt, that the warmth, which made it riſe, conſiderably exceeded the uſual warmth of the air in the dog-days; theſe gaged thermoſcopes being ſo fram'd, as to keep the liquor in the ſtem all the year long, without ſinking quite into the greater ball in winter, or aſcending into the leſs in ſummer.

We employed, alſo, when a young woman was blooded, a ſealed thermometer that was not gaged, but was much ſhorter than the other; and in this the ſpirit was raiſed almoſt to the top, which argued a conſiderable degree of heat.

The ſame thermometer being plunged into ſome blood of a healthy man, tho' it was already coagulated, it ſtill retained warmth enough to make the ſpirit of wine aſcend, at leaſt three or four fingers breadth.

Its inflammability.

Since human blood affords a conſiderable quantity of oil in diſtillation, it may well be ſuppoſed a combuſtible body; but every one will not think it ſo inflammable, as I, upon trial, found it. For having held a piece of human blood, dried till it was almoſt pulverable, in the flame of a candle, it would take fire, and afford a flame much like that which excited it; burning with a crackling noiſe, and here and there melting. But this inflammability much better appeared, when putting together four or five throughly kindled coals, we laid on them a piece of dried blood, of the bigneſs of a ſmall nutmeg; for this yielded a large and very yellow flame; and if it were ſeaſonably and warily blown, from time to time, as the effluvia degenerated into ſmoke, it would very long continue to yield clear and yellow flames, conſiderably large, in proportion to the body. And during a large part of this deflagration, the blood appeared, as it were, to fry upon the coals, and, in great meaſure, to melt into a black ſubſtance, almoſt like pitch. There was, alſo, a crackling noiſe produc'd, like that which chymiſts obſerve, when they decrepitate common ſalt.

Theſe experiments were repeated with the like ſucceſs. But there is another ſurprizing inſtance of the inflammability of human blood: for, having cauſed ſome to be ſo far dried, that it was reducible to fine powder, I took part of this powder, that had paſs'd a fine ſearce, and caſting it on the flame of a good candle, the grains, in their quick paſſage through it, took fire; and the powder flaſhed, not without noiſe, as if it had been roſin. This experiment was, alſo, repeated with ſucceſs.

And ſpecific gravity.

The ſpecific gravity of human blood is more difficult to determine, than one would readily imagine. For it may differ ſenſibly in ſeveral perſons, with their ſex, age, conſtitution, *&c.* and in the ſame perſon it may be varied by the time of the year, and of the day; and by being drawn at a greater or leſs diſtance from eating, *&c.* Beſides all this, there is a mechanical difficulty attending the experiment it ſelf; for the blood begins to coagulate ſo ſoon after it is emitted, that it is ſcarce practicable to weigh it hydroſtatically, either by immerſing into it a ſolid body heavier than it ſelf, or by plunging the whole in water; the former way being oppoſed by the fibrous part of the blood, and the latter by the ſerum. And, upon the ſame account, it is, alſo, difficult to compare, with any accuracy, the weight of blood: however, it may be of conſiderable uſe, to have ſome tolerable eſtimate of the difference in gravity between water and human blood; by which ſo many parts of the body, conſiſtent as well as fluid, are, by various changes of texture, both conſtituted and nouriſhed.

We, therefore, took the blood of a ſound man, emitted all at one time, and put the whole maſs, as well the ſerous as the fibrous part, into an oblong glaſs, of the fitteſt ſize and ſhape we could procure. And having ſuffered the blood to reſt till all was ſettled, and the bubbles vaniſhed, we carefully mark'd, with a diamond, that narrower part of the glaſs, to which the upper ſurface of the blood reached. Then we weighed the glaſs and the blood in a very good balance, and having pour'd out the blood, and waſh'd the glaſs, it was filled with common water, to the ſame mark, and weighed again in the ſame balance; afterwards the water being poured out, the glaſs, alone, was counterpoiſed in the ſame ſcales; and its weight being deducted from each of the two preceding weights, the water was found to be nine ounces, ſix drams, and fifty grains; and the blood ten ounces, two drams, and four grains: ſo that the difference between them being three drams, and fourteen grains, the blood was heavier than ſo much water by about the 25*th* part of its own weight.

What things coagulate the blood.

Tho' rectified ſpirit of wine be a menſtruum, conſiſting of very ſubtile parts, and, upon that account, a good diſſolvent of many vegetable ſubſtances, and, as experience has aſſured me, of ſome metalline ones too, which ſeem more ſolid than the fibrous part of human blood; yet having ſeparated from the ſerum, a clot of blood, that was coagulated, but ſoft, I kept it for ſeveral hours in a very well dephlegmed vinous ſpirit; from whence I afterwards took it out, as hard as if it had been well dry'd by the fire.

Having almoſt filled a vial, capable of containing near a pound of human blood, with a mixture of that, and ſome rectify'd ſpirit of wine, by gueſs a fourth, or an eighth part; at the end of above three years, looking upon the ſame glaſs, ſtopt with nothing but a cork, we found it coagulated, or of a conſiſtent form: when the veſſel being unſtopp'd, there appeared no ſign of putrefaction in the blood; and having ſmelt to it, we could not perceive that it was fetid: ſo balſamic a vertue has dephlegmed ſpirit of wine to preſerve it.

We took a piece of fibrous, or concreted blood, of the bigneſs of a large bean, and having put it into a ſmall glaſs veſſel, with a flattiſh bottom, we poured on it as much highly rectify'd vinous ſpirit, as might ſerve to cover it, tho' it had been twice thicker than it was;

then we covered this open-mouth'd glaſs with another, and ſet the veſſel in a quiet place, that the vinous ſpirit might have leiſure to imbibe the ſerous, or aqueous parts of the blood, and thereby harden that ſoft ſubſtance: and in effect it quickly ſeemed to have gain'd a ſuperficial cruſt; but the internal parts continuing yet ſoft, we left the liquor upon the blood for a day or two longer; and then found, that the action of the liquor had quite penetrated the lump of blood, and made it moderately hard and friable.

Having ſeparately put ſmall quantities of ſeveral acid liquors, as *Aqua fortis*, oil of vitriol, and ſpirit of ſalt, to blood, whilſt warm, as it came from the animal, I found they preſently turn'd it to a dirty colour, and coagulated it; on the other hand, the urinous ſpirits would make it look more florid, keep it more fluid, and long preſerve it from putrefaction.

I cauſed ſome of the conſiſtent part of human blood, to be, in an open ſhallow glaſs, expoſed to the air in a froſty night, and the next morning found it to be lightly frozen, and the ſurface of the ice prettily figured with images of combs, having teeth on both the ſides or edges; on which account theſe figures did not ill reſemble thoſe I have often obtained, by ſlowly coagulating into ſalt, a ſolution of ſal-armoniac made in common water.*

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* Dr. *Freind*, upon mixing various medicines with the freſh arterial blood of a dog, *Feb.* 12. obſerved as follows.

With *Spir. Nitr. dulc.* the blood immediately turn'd blackiſh, and became a very thick maſs; and both the blackneſs and thickneſs were increaſed on *Feb.* 13. *Spir. Salis dulc.* turn'd the colour very brown, but render'd the ſubſtance leſs thick than the ſpirit of nitre. *Spir. Nitr. Bezoart.* preſently turn'd the blood into a ſtrong coagulum, as if it had been putrefied. On *Feb.* 13. a very ſmall part of it remain'd thin, but browniſh. Oil of vitriol ſoon made it concrete, and cauſed a fermentation: its colour was blackiſh. On *Feb.* 13. the coagulum was leſs ſtrong than in the others; the ſerum being ſeparated from it. Spirit of nitre fermented and coagulated the blood, and gave it a browniſh hue. On *Feb.* 13. very much ſerum, lightly concreted, appeared on the top. *Aqua fortis* made a fermentation, and a ſtrong coagulation. *Feb.* 13. the maſs was black, thick, and clotted; but the ſerous part leſs ſo, than with ſpirit of nitre. The juice of birſtort gave almoſt the ſame phenomenon. Spirit of ſalt turn'd it much blacker than the *Spir. Salis dulc.* and made it of the thickneſs of a ſyrup; and thus it appeared, *Feb.* 13. The philoſophic ſpirit of vitriol cauſed a fermentation, and a coagulum of an aſh colour. Diſtill'd vinegar made a ſoft coagulum, of a colour a little dusky. This coagulum was ſtronger, *Feb.* 13. and more black. The *Tinct. Antiphthiſica* made a clotted maſs of a dusky colour; and thus it appeared *Feb.* 13. Spirit of vitriol made a very thick, muddy-coloured maſs. Balm of *Gilead* thicken'd the blood exceedingly, and made it appear as if 'twere putrefied. Salt of ſteel, and ſalt of vitriol, coagulated it; but left ſome part fluid. *Saccharum Saturni* made a middle concretion of a vivid colour. *Sal Prunel.* made a maſs ſomewhat clotted. The juice of ladies-mantle precipitated a black, clotted maſs, and left the other part ſufficiently fluid. *Freind Emmenolog.* p 176, 177.

With ſpirit of ſal-armoniac, the colour was exceeding florid, and the ſubſtance fluid. On the 18. it remained fluid, but appeared ſomewhat blacker. A decoction of ſavin, and of hore-hound, increaſed the redneſs and fluidity more than did the

MEDICINE.

The volatile ſalt of human blood, heterogeneous.

The volatile ſalt of human blood, tho' very fugitive, is yet ſo fuſible, that if it be dextrouſly managed, one part of it may be brought to melt, and, as I have tried, even to boil, whilſt the reſt is flying away. The like I have tried with ſome other volatile ſalts, and, I preſume, the obſervation will hold in moſt, if not in all of them.

Tho' the volatile ſalt of human blood, when 'tis, by ſublimation, made white and clean, ſeems to be very homogeneous; yet I am apt to ſuſpect, either that its ſubſtance is not altogether ſimilar, or that its component corpuſcles are of different ſizes, and perhaps of different ſhapes. For having weighed out ſome grains of a re-ſublimed ſalt of human blood, that ſeemed very pure, the odour was ſo ſtrong and diffuſive, that one would have expected the whole ſalt, being but ſix grains, ſhould, in a few hours, evaporate away; eſpecially being left in a ſouth window, expoſed to the air on a flat piece of glaſs: yet ſeven or eight days after, the ſalt ſeem'd to have waſted but little; and what remain'd, had ſcarce any odour at all: notwithſtanding which, this white body retain'd a ſaline taſt; and a little of it being put upon a ſolution of common ſublimate in fair water, readily turned it white. Whence it ſeemed, that the penetrating and diffuſive odour of the volatile ſalt of blood proceeded from ſome particles much more ſubtile and fugitive than the other parts which compoſed it.

Its temperature.

A dram of volatile ſalt of human blood, ſublimed in a lamp-furnace, was put into as much common water, as in a narrow cylindrical glaſs ſerved to cover the whole ball of our ſtandard thermometer, and

ſpirit of ſal-armoniac. *Sydenham*'s liquid laudanum, ſpirit of hartſhorn, the juice of ſage, lavender, maſter-wort, pennyroyal, and wormwood, made it more florid, but not much thinner than the decoction of ſavin. *Feb.* 13. the colour turn'd a little browniſh. *Jones*'s panacea of opium had the ſame effect with the laudanum; only on *Feb.* 13. the colour was leſs bright. Both rue-water and wormwood-water gave it a very great degree of fluidity, which remain'd unaltered on *Feb.* 13. Spirit of wine turn'd it to a coagulum, tough as bird-lime. On *Feb.* 13. it reſembled the conſerve of hipps, both in colcur and conſiſtence. Spirit of wine with camphire, and a tincture of opium made with it, had the ſame effect; only the coagulum was leſs viſcid. The tincture of *Peruvian* bark made with ſpirit of wine, render'd the blood exceeding thick and dark. On *Feb.* 13. 'twas ſomewhat brighter; but ſtrongly concreted. Wine ſatured with the ſame bark infuſed in it, gave it a very great degree of fluidity, and a moſt beautiful colour. A tincture of jalap, of ſcammony, and compound ſpirit of lavender, made the colour ſtrong and bright, and the ſubſtance thick. Tincture of amber and of tartar, turn'd it into a dusky colour and clots; and on *Feb.* 13. it was pretty ſtrongly coagulated. Calomel gave it a vivid red, and a great degree of fluidity; much ſerum floating on the top. Æthiops mineral precipitated a black maſs out of it, and left the other ſufficiently thin. Salt of broom gave it a vivid colour, and a greater degree of fluidity than is natural to it. Salt of wormwood greatly increaſed its colour and fluidity. Salt of tartar altered not its colour, but render'd it ſomewhat thicker than did ſalt of wormwood. *Lower*'s chalybeate tincture made it very red and thin; ſomething like an oily froth ſwimming on the top. *Emmenolog. p.* 160, 161.

when, after this had ſtood a while in the water, in order to become of the ſame temper with it, we put in the ſalt, the tinged ſpirit of wine manifeſtly ſubſided about two tenths of an inch, and probably would have fallen lower, if there had been more water in the veſſel, to make a ſeaſonable ſolution of the ſalt, whereof a conſiderable part lay undiſſolved at the bottom.

When we perceived the liquor to ſubſide no more, we put to it, by degrees, ſome ſtrong ſpirit of nitre, till it would no longer make any manifeſt conflict with the diſſolved ſalt. The event was, that the liquor in the thermometer began preſently to mount, and continued to do ſo as long as the conflict laſted; at the end of which we found, that it had aſcended more than three inches and a half, above the ſtation it reſted at when the ebullition began.

Its figures.

The figuration of the volatile ſalt of human blood may be conſidered, either in regard of the ſingle grains, or of that aggregate of them, which, when made to aſcend to the top of the glaſs, may be call'd its ſublimate. The latter of theſe may be beſt obſerved, when the ſaline exhalations firſt aſcend, and faſten themſelves to the inſide of the glaſs that is ſet to receive them. For tho' towards the end of the operation, the corpuſcles lie ſo thick and confuſed, as to leave no diſtinct figures; yet, at firſt, one may often obſerve the little ſaline concretions placed in rows, ſometimes ſtreight, and ſometimes more or leſs crooked, with differing occurſions and coherencies; ſo that tho' ſometimes ſuch rows of concretions may repreſent either trees, their branches, hartſhorn, *&c.* yet theſe ſeem not to be conſtant repreſentations, depending upon the particular nature of human blood; but caſual figurations, that depend upon ſeveral accidental cauſes and circumſtances; ſuch as the degree of fire employed to ſublime the ſalt, *&c.* Nor is the ſalt of human blood the only volatile one, among whoſe elevated concretions I have obſerved the like circumſtances to produce diverſity of configurations. But as to ſingle grains of the volatile ſalt of blood, I diſcerned many of them to be finely ſhap'd; tho' whether it were accidental or not, further tryal muſt inform me. I could not, that I remember, obſerve theſe handſome figures in the concretions which compos'd the ſublimate, obtained by rectifying, or elevating again, the ſalt that firſt came over, but in the grains that, in the firſt diſtillation, faſten themſelves to the upper part and ſides of the receiver; for ſeveral of theſe were of conſiderable bigneſs and ſolidity: and tho' they were not all of the ſame ſhape; ſome of them being not unlike to cubes, others to parallelopipeds, and others to octoedrons; yet moſt of them were prettily ſhaped, being comprehended by ſmooth planes, finely figured, and aptly terminating in ſolid angles, as if the concretion had been cut and poliſhed by a jeweller.

There is another way that I have uſed to obſerve the figures of the ſalt of blood; which was to rectify the ſpirit of blood, ſo that it might be fully ſatiated with the ſalt, whilſt the liquor (in the receiver)

ver) continued yet ſomewhat warm. For then ſetting aſide this over-impregnated liquor; when it came to be quite cool, there appeared at the bottom of the vial a large number of ſaline concretions of differing ſizes; ſeveral of which, as far as the reſt would ſuffer me to ſee them, were ſhot into cryſtalline plates, very ſmooth, and prettily figured; having their broad and parallel ſurfaces of a hexagonal or regular octogonal figure.

We took a dram of dry volatile ſalt of blood, and having diſſolv'd it in diſtill'd water, we dropt into it good ſpirit of nitre, till the two liquors, tho' they were ſhaken, would no longer manifeſtly act upon one another; the conflict being ceas'd, we ſlowly evaporated the ſuperfluous moiſture, which ſteam'd almoſt all away before the ſaline part would coagulate. At length it became dry, and then the middle part appeared in the form of thin cryſtals, like thoſe of ſalt-petre; but the reſt, which was by much the greater part of the concretion, ſeem'd to be a confuſed maſs, without any diſtinct figure. This maſs weighed but one dram and twelve grains; ſo that, as far as this ſingle experiment can inform us, the volatile ſalt of blood may be ſatiated by a fifth part of its weight of the ſaline corpuſcles of ſpirit of nitre. This compounded ſalt being laid in a window, appeared apt to reſolve by the moiſture of the air; and a little of the ſaid ſalt being put on a well-kindled coal, readily melted, and ſeem'd to boil, and towards the latter end, made a noiſe, and afforded a flame very like common nitre, only its colour was more yellow. The ſtrong ſmell that accompanied this deflagration, was like that peculiar to ſpirit of nitre.

To try how much volatile ſalt an aſſigned quantity of water wou'd diſſolve, we took three ounces of diſtill'd water, and put into it, by degrees, ſome dry white ſalt of ſal-armoniac, keeping the liquor in digeſtion till it had diſſolved as much as it cou'd; then we took it out, and found, that after ſtanding for ſome hours in the cold, there ſettled about the bottom of the glaſs, a conſiderable quantity of ſalt, ſuppoſed to be two drams; which being deducted from two ounces, which had, in all, been employed, there remains once ounce and, ſix drams in the liquor, which, by this account, had diſſolved above half its weight of ſalt.

Diſpoſition to diſſolve in water.

Having cauſed an ounce of diſtill'd water to be carefully weigh'd out, we put into it, little by little, ſome dry white volatile ſalt of blood, and ſhook it well into the liquor, to make it diſperſe the better; we allowed it, alſo, a competent time for ſolution, and by this means found, that one ounce of water would diſſolve at leaſt two drams, that is, a fourth part of its weight, of dry ſalt, and that in the cold. Afterwards, by the help of heat, we made the ſame liquor diſſolve near five and twenty grains more.

We put this ſolution into a retort, to be drawn off with a quick heat, and thereby had a diſtill'd liquor, that contain'd all the volatile ſalt, except a little that eſcaped in a dry form; which liquor taſted ſtrong enough to paſs for as briſk an one, as moderate ſpirit of blood, drawn in the common way; and conſequently diſcovers what proportion ſhould be taken, of the aqueous ingredient to the ſaline, to make ſuch a ſpirit.

And to freeze and be frozen.

And having ordered the vial that contained this aqueous ſpirit, to be kept ſtopp'd during a froſty night, we perceived at the bottom of the glaſs a pretty deal of volatile ſalt, coagulated or ſhot into cryſtals, which were fine and clear, and ſome of them larger than ſpangles; yet being much more numerous than we deſired, and adhering cloſely and confuſedly to one another, they kept us from diſcovering the figure of the particular grains; and made me doubt, whether the ſingle cryſtals were of the ſame ſhape; all that I could clearly diſcern being, that ſeveral of thoſe concretions were flat thin plates, with fine rectilinear angles, that inclin'd us to think, if the whole plains could have been perfectly diſcovered, their broadeſt ſurface would have been hexagonal, or of ſome polygone figure, very near of kin thereto.

We put an ounce of diſtilled water, wherein was diſſolved as much volatile ſalt of human blood as it would well take up, into a glaſs egg, and expoſed it, during a froſty night, to congeal; hoping to diſcover, whether, as the ſaltneſs that is in ſea-water keeps it, here in *England*, from freezing, ſo the volatile ſalt of human blood, which much reſembles the other in taſt, would have the like effect upon water, eſpecially if it were fully impregnated therewith. To this conjecture the event was anſwerable; the froſt having produced no ice in our ſolution, nor ſo much as made any of the ſalt manifeſtly ſhoot. And tho' afterwards we remov'd it into a frigorific mixture, that would, probably, have frozen beer and ale, and, perhaps, the weaker ſort of *French* wine; yet we did not perceive it to turn any part of our ſolution into ice; but only made it let fall a pretty deal of matter that ſeemed feculent.

Sea-ſalt diſſolved in water, renders it much more difficult to be frozen than it was before; yet being join'd with ice or ſnow, the other ingredient of our frigoric mixture, it does, when outwardly applied, very much conduce to the artificial congelation of it; which uſually would not ſucceed without it. Wherefore, to try whether, as volatile ſalt of human blood, being diſſolved in water, hinder'd it from freezing, ſo it would, outwardly apply'd, highly promote its glaciation; we mixed about a ſcruple of this ſalt, with a convenient quantity of beaten ice; and having put into this mixture a ſlender pipe of glaſs, with common water in it, we found, after a while, the water that lay in the lower part of the glaſs veſſel, and was ſurrounded by the mixture, turned to ice.

The oils of human blood.

Human blood, like moſt of the other ſubjects of the animal kingdom, that I have had occaſion to examine, afforded, by diſtillation in a

retort,

Medicine.

retort, an empyreumatical and very fetid oil, whoſe colour was almoſt black; but that ſeem'd to proceed only from the intenſe and opake redneſs of the liquor, ſince ſome portions of it being viewed againſt the light, when ſpread very thin upon glaſs, appeared of a deep yellow, or of a reddiſh colour, as they chanced to lie more or leſs thick.

When the blood was well dry'd, before we committed it to diſtillation, I found it to afford a greater quantity of oil, in proportion to the weight of the dry body, than was at firſt expected. Once, out of a pound of it not over-dry'd, we had near an ounce and an half of oil; and from another parcel, we had it in a far greater proportion to the quantity of blood that afforded it.

Having prepared blood, by a very convenient digeſtion, and rectified, very carefully, the diſtilled liquors that came over, with the flame of a lamp; I obtained, among other things, two oils of very different colours; the one of a yellow, or pale amber, and the other of a deep red. But it was ſurprizing, that tho' theſe oils were both of them afforded by the ſame blood, and were clear and pure, yet they would not only ſwim in diſtinct maſſes one over another; but, if they were confounded by being ſhaken together, would gradually ſeparate again, as common oil and water. Whether the difference in ſpecific gravity between theſe two oils, could keep them from permanently mixing, as it kept their maſſes diſtinct before they were ſhaken; or whether this ſeeming antipathy proceeded from ſome particular diſagreement in the textures of theſe liquors, I ſhall not here conſider.

Suſpecting that the oil of blood might contain ſaline particles, capable of being ſeparated from it, we took a parcel of unrectified oil of human blood, and having put to it a convenient quantity of diſtill'd water, we throughly confounded theſe liquors by frequent agitation, that the water might rob the oil of its ſeparable ſaline corpuſcles; and after the liquors were well ſettled, the water was found impregnated with ſaline corpuſcles, that it had, by diſſolution, obtained from the oil; by virtue of which, it was endowed with a moderately briſk taſt, would readily turn ſyrup of violets green, precipitate a white powder out of a ſolution of common ſublimate, and otherwiſe reſembled weak ſpirit of human blood.

We put ſome unrectified oil of human blood, into a concave piece of glaſs, and having dropt into it as much oil of vitriol, as might amount to a fourth, or a third part of the fetid oil, we ſtirr'd them well together with a ſlender piece of ſolid glaſs; by which means the mixture was made to ſend up abundance of whitiſh fumes, or ſmoke, and grew ſo hot, that tho' the quantity was above a ſpoonful, yet, without pain and inconvenience, I could not hold my finger underneath the containing glaſs.

Having taken ſome unrectified oil of human blood, tho' in that ſtate it appeared groſs, dark, and muddy, yet it would readily, even in the cold, diſſolve in, or mix with high rectified vinous ſpirits, to which it communicated a deep reddiſh colour.

Fixed ſalt.

I do not remember to have any where met with an account of the qualities of the fixed ſalt of human blood, and I know not whether any one has prepared it; and no wonder, ſince to obtain ſo much as one ounce of it, there is requiſite a conſiderable quantity, perhaps ſome pounds of blood; and the calcination requires ſo obſtinate a fire, that a man's patience may eaſily be tired before the operation be perfected; or, by the ſmall appearance of calcination, that the *Caput mortuum* will afford him, after having been kept for three or four hours in the fire, he may be induced to conclude, that all the ſalt of blood is volatile in a large fire; and, conſequently, that it will yield no fixt ſalt.

But having, by an obſtinate calcination, obtained between three and four drams of this ſalt, I found not that it was a fix'd alkali, or a lixiviate ſalt, but rather of the nature of common or ſea-ſalt; tho' not without ſome little difference, which diſcover'd it ſelf by ſome nice trials. But, in the general, our ſalt was ſcarce diſtinguiſhable from marine ſalt; for it taſted very like that; and a ſtrong ſolution of it did not readily turn ſyrup of violets green or greeniſh, nor precipitate a brick-colour'd, a browniſh yellow, or a white powder, out of a ſolution of ſublimate. I alſo found, that the ſpirit of ſalt did not diſſolve it as an alkali. Having put ſome oil of vitriol upon a little of our dry ſalt, that immediately corroded it, with great violence, and with much foam and ſmoke, as it does common ſalt. We, alſo, dropt a little of our fix'd ſalt, diſſolved in diſtill'd water, upon a ſolution of fine ſilver, made in *Aqua fortis*, whence immediately enſued a large precipitation of a white powder. And, laſtly, having put ſome leaf gold into *Aqua fortis*, and added a little of our powder'd ſalt to the liquor, it was thereby turned into a kind of *Aqua regia*, and did in a trice, without the aſſiſtance of heat, totally diſſolve the gold.*

Caput mortuum.

A far greater calcination than one would expect, is required to obtain the *Caput mortuum* of human blood, which affords but very little of it. For from twenty four ounces of dry'd blood, we could get, after two days calcination, but two drams, and nine grains of earth. And tho' this were ſo carefully made, that it may very probably be ſuppos'd to deſerve the name of *Terra damnata*, better than moſt ſubſtances to which chymiſts uſually give that appellation, yet one may ſuſpect, that this it ſelf was not pure elementary earth; ſince it had a red colour, very like that of colcothar of vitriol.

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* That an acid, or what is commonly called ſo, and judged of by the change of colour it cauſes in ſyrup of violets, *&c.* may be drawn from the blood of animals in general, and from human blood in particular, ſeems proved by the repeated experiments of M. *Homberg*; who, for greater ſecurity in the analyſis he made of them, employed for his addition only the *Caput mortuum*, or friable ſpongy coal of animal blood it ſelf; whilſt M. *Vieuſſens* made uſe of bole, *&c.* in his diſtillations. From hence, and from the careful analyſes which this great chymiſt has alſo made, of plants, and the fleſh and excrements of ſeveral animals, particularly the human; it appears, that the acid, (or ſea-ſalt,) of the aliment taken into the bodies of animals, is not deſtroyed therein, but paſſes into the ſubſtance of them; the ſuperfluous portion being return'd unalter'd along with the excrements. See *Memoir. de l'Acad.* A. 1712. p. 9—18. and p. 352—363.

The proportions of its principles upon a chymical analyſis.

The quantities of the principles, or rather of the ſeveral differing ſubſtances obtainable, by diſtillation, from human blood, are very difficult, if poſſible, to be determined; becauſe of the great diſparity, as to proportion, that may be met with, of the fibrous, or concreted part to the ſerum, in the blood of different perſons, and even of the ſame perſon, according to different circumſtances; and becauſe it is more difficult to diſtil even the dried and pulverable part of blood, without addition, than thoſe who have not try'd will eaſily imagine: and I doubt few have try'd it well, becauſe I have not met with any who take notice of the neceſſity of ſhifting the retort, to gain as much volatile ſubſtance as may be obtained, and leave as little as poſſible in the *Caput mortuum*. For when we diſtilled a conſiderable quantity of dry'd blood, tho' it was warily done by an expert artiſt; yet the ſame heat that made the lower part of the blood paſs, in the form of exhalations, into the receiver, made the ſubject ſo ſwell, that it raiſed to the upper part of the veſſel a conſiderable quantity of black matter, which an ordinary operator would have thrown aſide for *Caput mortuum*, tho' a heedful eye might eaſily diſcern it to be much of the ſame nature with what was firſt put in, but blacked by the aſcending fumes. We, therefore, took it out, and mixing it with the remaining ſubſtance, that was leſs remote from the nature of a true *Caput mortuum*, it was again, in another retort, committed to diſtillation; whereby we obtained more oil, *&c.* And perceiving even this ſeeming *Caput mortuum* had, at the top of it, a pretty deal of matter, that I did not think ſufficiently diſpirited; I cauſed it to be taken out, and diſtill'd in a freſh retort, in which it afforded a conſiderable quantity of volatile matter.

And having thus, in three retorts, diſtilled twenty-four ounces of dry'd human blood, we obtained of volatile ſubſtances, I mean ſpirit, together with a little phlegm, white ſalt, and a very high-coloured oil, thirteen ounces, and one dram; beſides ſeveral parcels of thick oil, that ſtuck to the retorts and the receivers, which we eſtimated at ſeven drams more. So that the whole quantity of the volatile part amounted to fourteen ounces, of which we found the oil to be about three ounces, and ſix drams; and the clear liquor ſix ounces, three drams and an half; beſides the volatile ſalt, which, when the ſpirit was drain'd from it, appeared white, but wet: for which reaſon 'twas not poſſible to determine exactly, neither how much liquor it yet retained, nor, conſequently, how much it ſelf weigh'd. But having carefully ſublimed the ſalt, there remained in the glaſs two drams, and about five grains of phlegmy liquor, which was not judged free from ſalt, tho' it could not by that operation be ſeparated. And of volatile ſalt, in a dry form, we obtained one ounce, two drams, and an half. The *Caput mortuum* amounted to above eight ounces and an half; which being calcined, for two days together, afforded only browniſh red aſhes; whence we obtained ſeven drams and a quarter of white and fix'd, but not truly lixiviate ſalt; and two drams, and nine grains of earth. But in this troubleſome experiment there occurred many neceſſary operations, in each of which we could ſcarce poſſibly avoid loſing ſome, and now and then a conſiderable portion, of the matter.

I cauſed twelve ounces of dry'd blood to be carefully diſtill'd, and the diſtillation being ended, we found that the twelve ounces had yielded five of volatile ſalt and ſpirit together, of which we poured off from the wet ſalt thirteen drams, and fifty-four grains; ſo that there remained three ounces, two drams, and ſix grains of volatile ſalt; of fetid oil there were two ounces; of *Caput mortuum* four ounces and two drams; ſo that, in ſpite of our care, there were loſt about ſix drams. The four ounces and two drams of *Caput mortuum* being diligently calcin'd, afforded but ſix drams and a half of aſhes; of which very great decreaſe, the conſumption of the more fix'd oleaginous part ſeem'd to be the cauſe. And if ſo, we may ſuppoſe there is a far greater proportion of oil in human blood, than has hitherto been taken notice of. Theſe aſhes were not white or grey, as thoſe of other bodies uſe to be, but of a reddiſh colour, much like that of bricks; and yet my aſſiſtant affirm'd, he could eaſily know them to be true aſhes, becauſe, whilſt there remained any thing oily or combuſtible in the *Caput mortuum*, it would look like a throughly kindled charcoal; but when that combuſtible ſubſtance was quite waſted, the remaining *Caput mortuum* look'd, in the fire, like dead and ordinary aſhes; tho' when they were cold, they appeared and continued red. Theſe aſhes being carefully elixiviated, afforded five ſcruples of white fix'd ſalt, beſides a little, which being caſually got into the contiguous ſand, but thence recovered by water, and reduced to the like white ſalt, amounted to about a ſcruple more. So that there remain'd for the *Terra damnata*, thirteen ſcruples and about a half; that is, above twice the weight of the ſalt: whence it appears, that, according to this analyſis, the pure fixed ſalt of human blood is but between the 57*th* and 58*th* part even of dry'd blood; and, therefore, probably amounts but to the 150*th*, or, perhaps, the 170*th* part (in weight) of blood, as it flows from the vein opened by a lancet: and the fix'd earth, or *Terra damnata*, is to the dry'd blood that affords it, as 19, and about a half to 1.

An entire parcel of human blood, weighing ten ounces, and ſeventy three grains, being ſlowly diſtilled to dryneſs in a head and body on a digeſtive furnace, afforded of phlegmy liquor ſeven ounces, two drams, and forty-ſeven grains; and of *Caput mortuum*, or rather of dry ſubſtance, two ounces two drams. This pulverable matter being beaten, put into a retort, and diſtill'd in ſand, by degrees of fire, afforded two drams forty-eight grains of oil. But there happen'd an unlucky miſtake about the ſalt and ſpirit: for after the latter was poured off, which weighed but forty-eight grains, the wet ſalt, which ſtuck in a large quantity to the lateral and upper parts of the receiver, inſtead of having been waſh'd out, with the phlegm of the ſame blood, was waſh'd out with diſtill'd water, whence we obtain'd by ſublimation, into the neck of a glaſs-egg, one dram and five grains of dry ſalt. But, by the taſt of the diſtill'd water, whence it was ſublimed, it appeared, that all the ſalt had not been raiſed: I, therefore, put to it as much good ſpirit of ſalt as I ſuppoſed to be at leaſt ſufficient to ſatiate it, with deſign to try, whether by evaporating this mixture to dryneſs, and ſubliming the ſalt by the help of an alkali, we might not recover the volatile ſalt, that had been ſomewhat fixt by the acid ſpirit. The retort being broke, that the *Caput mortuum* might be taken out, it was found to weigh ſix drams and twelve grains; which being carefully calcined, yielded but two ſcruples and four grains of aſhes, which were red. Theſe being elixiviated, afforded eighteen grains of ſalt, beſides the remaining earth or terreſtrial ſubſtance, which I keep by me; becauſe, notwithſtanding all the violence of the fire it has undergone, 'tis of a red colour, with an eye of purple.

SECT. II.

Obſervations upon the ſerum of human blood.

A Young man having bled into a porringer, and the blood having been kept for ſeveral hours, that a ſufficient ſeparation might be made of the conſiſtent part and the fluid; they were ſeparately weigh'd, when the former amounted to about ſix ounces, and the ſerous part to near the ſame weight.

Since the diviſion that nature her ſelf makes of human blood, when being let out of the veins, and ſuffered to cool and ſettle, is into a fluid or ſerous, and a conſiſtent or fibrous part; and ſince 'tis often found, that the former of theſe parts either equals or exceeds the latter in quantity, I thought it might conduce to ſhew the nature of the blood, to make ſome tryals upon the ſerum apart.

Its proportion to the red part.

And firſt, having weigh'd the ſerum, and the conſiſtent part of a parcel of human blood, obtained, at once, by a ſingle phlebotomy, we found the latter to be four ounces ſix drams and an half, and the former three ounces and ſix drams. And having made the like tryal with another parcel of blood, drawn from another perſon, the fibrous part weighed four ounces, five drams; and the ſerum four ounces. But tho' in both theſe tryals the weight of ſerum that appeared in one maſs, was inferior to that of the fibrous part; yet it could not be ſafely inferred, that, abſolutely ſpeaking, the fibrous part of either of theſe parcels of blood exceeded the other; ſince we weighed only the ſerum that we found in a diſtinct maſs; whereas a multitude of ſerous particles may well be ſuppoſed to be lodged between the parts of the conſiſtent maſs; for, probably, 'tis upon account of the interſperſed ſeroſity that it is ſoft; and beſides, it affords a great deal of aqueous liquor. And this may ſufficiently appear by the following experiment, which was purpoſely made, to examine the conjecture.

We took a porringer of blood, wherein the ſerum was ſeparated from the fibrous portion, that was coagulated into one conſiſtent maſs; and having carefully poured off all the fluid part, we put the remaining maſs (which weighed four ounces, five drams, thirty-four grains) into a ſmall head and body, and diſtill'd it in a digeſtive furnace, till the matter, left in the bottom of the cucurbit, was quite dry; then taking out the ſeparated parts of this red maſs, the dried portion was found to weigh one ounce, three drams, thirty-four grains. But the ſerous liquor that paſs'd into the receiver, being limpid and aqueous, without any ſhew of ſalt or oil, amounted to three ounces, fifty-three grains. We repeated this experiment with the fibrous part of another parcel of human blood, and found the dry maſs, remaining in the cucurbit, to weigh one ounce, ſix drams, and fifty grains. But the phlegmy liquor, diſtill'd from it, amounted to ſeven ounces.

Its ſpecific gravity.

Having hydroſtatically examin'd the ſerum of human blood, we found it heavier than common water. For a piece of red ſealing-wax, being ſuſpended in a good balance by a horſe-hair, was found in the air to weigh one dram fifty-ſix grains, and in the water thirty-five grains; but in the ſerum only thirty-three grains. This tryal was confirmed by a more exact one, made with an inſtrument that I purpoſely deſigned for weighing liquors nicely; in which, when common water weighed two hundred fifty-three grains, an equal bulk of ſerum weighed three hundred and two. And ſuppoſing different ſerums of human blood would not be of equal ſpecific gravity, I try'd that of the blood of another perſon in the ſame inſtrument, and found it to weigh two grains leſs, that is, three hundred grains in all.[*]

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[*] Some experiments made by Dr. *Jurin*, ſhew, that the red part of the blood is ſpecifically heavier than the ſerum; that the red globules are not filled with any elaſtic fluid; that the ſpecific gravity of the ſerum, drawn off from the red part, is, at a medium, to water 1030. to 1000; but the ſpecific gravity of the blood it ſelf as 1054; whence blood is heavier than ſerum by about one part in 43; that the ſerum, which may be poured from the *Craſſamentum*, with the quantity remaining in the interſtices of the latter, is, probably, about three fourths of the whole; and that the red part of the blood conſiſts of ſome phlegm, united with oil and ſalts, and a ſmall quantity of earth. But, adds this learned gentleman, what is the exact proportion of theſe ſeveral principles to one another; what alterations are produced:

We once employed ſome ſerum which was not poured off ſo clear, but that it appeared of a reddiſh colour; and tho' we filter'd it thro' cap-paper, yet a large number of the tinging corpuſcles were ſo thoroughly mixed with it, that the liquor paſs'd thro' the filtre of a yellow colour.

The ſerum of human blood mixed with various ſubſtances.

To try whether acids would coagulate our ſerum, as I had found they would ſome other animal liquors, I dropt ſpirit of ſalt into it, which immediately produced ſome white concretions, that quickly ſubſided to the bottom, and there appeared like a very light and tender cheeſe-curd.

The like operation, but more powerful, oil of vitriol had upon another parcel of ſerum. We alſo dropt into ſome of our liquor, good ſpirit of ſal-armoniac, which made it rather more fluid.

To try whether theſe precipitations did not more proceed from the coalition and texture of the acid ſalts and the ſerum, than barely from the peculiar action of thoſe ſalts as acids, we dropt into another portion of our ſerum oil of tartar *per deliquium*, which inſtantly produced a white curd, as the ſpirit of ſalt had done, but not, as it ſeem'd to us, ſo copiouſly. We poured, alſo, upon ſome ſerum highly rectified ſpirit of wine, which preſently coagulated part of it into a large white curd, that appeared much lighter than any of the former; for it would not, like them, ſubſide; but kept at the top of the liquor.

To try, alſo, what a ſalt compounded with a metal, would do upon our ſerum, we put to it a little ſtrong ſolution of ſublimate, with which it preſently afforded a white and curdled ſubſtance.

We put ſome of our ſerum upon filings of ſteel, but by reaſon of the colour of the liquor it ſelf, we could not ſatisfie our ſelves about the event. And tho' we afterwards put another parcel of ſerum upon filings of the ſame metal, yet neither did this give us ſatisfaction; becauſe the vial having been miſlaid, it was not viewed again till many days after; at which time the liquor was grown ſo thick and muddy, that we could not well diſcern any more of the colour, than that it was ſomewhat dark, but not either black or blackiſh; yet by a tryal or two, that we made with a little of this liquor, it ſeemed to have diſſolved ſome part of the ſteel: for putting it to ſome freſh infuſion of galls made with water, it preſently afforded a large precipitate; tho' this was ſo far from being inky, that it was not ſo much as dark coloured, but rather whitiſh. And having mixed with ſome

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ced in the body by the change of this proportion; how and in what part the red globules are form'd; by what means they preſerve their figure, without diſſolving in the ſerum, or uniting with one another; what variations are made in their ſpecific gravities by heat and cold, with the effects of thoſe variations, are queſtions not very eaſy to be ſolved, and yet of ſuch importance to the animal œconomy, that it were greatly to be wiſh'd we had ſufficient *Data* to determine them. See *Philoſ. Tranſ. No.* 361. *p.* 1000.

of our impregnated ſerum, a convenient quantity of infuſion of galls, made in a highly rectified vinous ſpirit, the two liquors not only afforded a kind of coagulum, or precipitate, but being left together for ſome hours, aſſociated into a conſiſtent body, wherein the eye diſcovered no diſtinct liquor at all.

But expecting better ſucceſs, by putting ſome of our liquor upon filings of copper, which when wrought upon by bodies that have in them any thing of urinous ſalt, give a conſpicuous tincture; we found, accordingly, that the metal had in a very few hours diſcoloured the menſtruum: afterwards, the vial being left unſtopp'd, it began by degrees to grow gradually blue; and within a day more was of a deep blue colour.

And, to confirm our conjecture, that this tincture proceeded from particles of volatile ſalt, latent in the liquor, we mix'd ſome of it with a convenient quantity of ſyrup of violets, and thereby obtained a colour, which, by reaſon of the action of thoſe particles upon the ſyrup, appeared of a fine green.

Our blue tincture, or ſolution of copper, I thought fit to keep for ſome time, to try whether the metalline particles would, as it were, embalm the ſerum they were diſpers'd through, and preſerve the liquor from putrefaction. And, in effect, tho' the vial was left unſtopp'd in a window for many weeks, yet I did not perceive the liquor to grow at all fetid.

Expoſed to the air.

About two ounces of ſerum of human blood, were left in an unſtopt vial for twenty days, or three weeks; and tho' the glaſs uſually ſtood in a ſouth window, and in the month of *July*, yet, to our wonder, the ſerum did not, by the ſmell, appear putrefied; yet had let fall a conſiderable quantity of whitiſh ſediment; but within three or four days after this, the liquor was found to ſmell offenſively. We therefore try'd, whether this putrefaction was accompanied with any acidity, but could not perceive that it was; ſince it would not ſo much as take off the blue colour of the infuſion of *Lignum nephriticum*. When it was in this ſtate, we put it to diſtil in a low cucurbit, with a gentle fire, to try if from this fetid liquor, as is uſual from putrefied urine, the ſpirit would firſt aſcend: but we found the liquor that firſt came over, to be ſo little ſpirituous, or ſaline, that it would not in an hour's time turn ſyrup of violets green. Yet we judg'd it not quite deſtitute of a volatile alkali; becauſe having let ſome of it fall into a ſolution of ſublimate, it preſently made a white precipitate.

Analyſed by the fire.

We took ſome ounces of ſerum of human blood, filtred thro' cap-paper, to free it from all concreted ſubſtance; and having committed it to diſtillation in a ſmall retort, placed in a ſand furnace, we obtained only a few large drops of a darkiſh red oil; ſome of which ſubſided to the bottom of the other liquor, but the greater part ſwam upon it. We obtained, in this firſt diſtillation, no volatile ſalt in a dry form; but after a pretty deal of inſipid phlegm had been drawn off, there

MEDICINE. came over a large proportion of ſpirituous liquor, which ſmell'd almoſt like the ſpirit of blood, and contained much volatile alkali; ſo that it would readily turn ſyrup of violets green, make a white precipitate in the ſolution of ſublimate, and cauſe a great ebullition with ſpirit of ſalt. This ſpirit being rectified in a ſmall head and body, there was left in the bottom of the glaſs a greater quantity than we expected, of a ſubſtance thick like honey; and which was, for the moſt part, of a dark red, and ſeemed to contain more oil than appeared upon the firſt diſtillation. The liquor that came over the helm ſeemed more pure, but not very much ſtronger than the firſt ſpirit. Yet having put it into a glaſs-egg, with a ſlender neck, and given the veſſel a convenient ſituation in hot ſand, we obtained a volatile alkali, that ſublimed into the neck, in the form of a white ſalt. This ſhould ſeem to argue, that the ſerous, or fluid part of the blood, affords the ſame elementary principles, or ſimilar ſubſtances, both as to number and kind, with the fibrous and conſiſtent part, tho' not as to quantity; that of the oil and of dry ſalt being leſs in a determinate portion of ſerum, than they would be in a like quantity, or weight, of the concreted part of the blood.

With additions. Having obſerved, that tho' the ſpirituous parts of human urine, require the liquor to be long digeſted, or putrefied, to looſen them from the more ſluggiſh parts, and make them aſcend before the phlegm; yet, if freſh urine be poured upon a due portion of quick-lime, a large part of the ſpirit will preſently be ſet looſe, and made capable of aſcending in diſtillation; I thought it worth while to try, what would be afforded by the ſerum of human blood put upon quick-lime, before we diſtill'd it. In purſuit of this enquiry, we put theſe two bodies together, upon whoſe commixture there enſued a ſenſible, but tranſient heat. This compounded body being committed to diſtillation, afforded, firſt, a kind of phlegm in a gentle fire; and then, in a ſtronger, a moderate quantity of liquor, that was thought to ſmell manifeſtly of the lime, but had not a briſk taſt; tho' accompanied with ſomewhat more of a high-coloured, and fetid oil, than was expected.

The other liquor being ſlowly rectified, the ſpirit that firſt came over had a ſtrong and piercing ſmell, but leſs rank than that of human blood, drawn after the ordinary way. Being dropt upon ſyrup of violets, it preſently turn'd it green; with a ſtrong ſolution of ſublimate in water, and another of quickſilver in *Aqua fortis*, it immediately made two white precipitates; and being mixed with good ſpirit of ſea-ſalt, tho' upon their being confounded there appeared a thick, but whitiſh ſmoke; there was not produced any conflict or bubbles; tho' the colour of the ſpirit of ſalt appeared much heightened by this operation. And having put the mixture of the ſpirit of ſerum, and of ſalt, to evaporate, that we might obſerve whether it would afford a ſalt figured much like ſal-armoniac; we found that it did not; but that the colour produced in the mixture whilſt [illegible]d, was ſo heightned in the concretion, that it appeared of a blood-red colour; but for the ſhape, it was ſo confuſed, that we could not reduce it to any known kind of ſalt. By all which phenomena, this ſpirit of the ſerous part ſeems to be very near of kin to that of the concreted part of blood.

Quick-lime being ſuſpected of a cauſtic and fretting quality, I thought fit to try, whether the fix'd ſalt of pot-aſhes being ſubſtituted in the room of it, would, in diſtillation, have the ſame effect upon ſerum of human blood. Wherefore, to four parts of the liquor, we put one of the ſalt; and having diſtill'd them, ſlowly, in a glaſs head and body, we obtained much of a liquor, which was not judg'd any thing near ſo ſtrong, as that drawn off from quick-lime. And, having put this weak liquor, afforded by our ſerum, to rectifie with a gentle heat, we found even the two ſpoonfuls of liquor that firſt aſcended, were very phlegmy; nor would it well turn ſyrup of violets green, tho' it afforded ſome little and light precipitate when put upon a ſolution of ſublimate.

This will ſeem the more remarkable from an experiment that may be ſometimes of practical uſe, eſpecially in phyſic; and may afford light to thoſe who are ſtudious to know the nature and preparations of human urine. We took, then, three parts of freſh urine, and having put into it one part of ſalt of pot-aſhes, and ſlowly diſtill'd them in a head and body; there firſt aſcended a ſpirituous liquor, which being ſet aſide, we continued the diſtillation in a retort, till the remains appear'd dry. In the operation we obtained not one drop of oil; whilſt this ſpirit of urine was not near ſo fetid, as that made in the common way; and the liquor that came over toward the latter end of the diſtillation, was ſo unlike that which the ſerum of blood afforded, that it was not only conſiderable ſtrong, and manifeſtly ſtronger than that which firſt aſcended, but had a penetrating and fiery taſt, which left a laſting impreſſion upon the tongue; and with good ſpirit of ſalt it made a notable ebullition, which the ſpirit of urine, drawn from quick-lime, did not. And tho' with this laſt liquor, I never found any volatile ſalt to aſcend, in a dry form; yet in the operation made by the help of ſalt of pot-aſhes, there came up, without rectification, ſeveral grains of volatile ſalt, one of which was cryſtalline, and conſiderably large.

But in repeating this experiment, we had not ſo good ſucceſs; the liquor that came over appearing much more phlegmy than before; tho' we both times employ'd ſalt of pot-aſhes, taken out of the ſame veſſel; and the urine of the ſame perſon: yet this liquor that appeared ſo weak at its firſt coming over, being rectify'd *per ſe*, afforded more than was expected of a brisk, ſaline ſpirit; from which we eaſily obtained a large quantity, in proportion to the liquor, of volatile ſalt, in a dry form, and of a very white colour.

The ſerum of human blood long kept hermetically ſeal'd up.

We took between two and three ounces [illegible] ſerum of human blood, and having put it into a bolt-head, capable of containing about four times as much, and ſeal'd the glaſs hermetically, we ſet it by.

After we had kept the liquor ſeal'd up for above a whole year, it did not appear to be at all coagulated, nor to have let fall any manifeſt reſidence; but ſeemed to be as fluid as when it was firſt put up.

It did not appear to have bred the leaſt worm, or maggot; and, for my part, I never obſerved worms, or inſects, to be generated in blood, tho' very long kept and putrefied, provided it were freſh enough when put into the glaſs; and by an exact cloſure kept from being any way blown upon by flies, or impregnated by ſeminal particles, that may unexpectedly be conveyed to it by the air. Nor did there appear to the eye, any mother, or recrementitious ſubſtance, that is ſuppos'd, in liquors, always to accompany, and betoken putrefaction.

One deſign in our experiment being to try, whether the ſerum would, by the mutual action of the parts upon one another, or by that of ſome univerſal permeating fluid, afford ſo much air, as could either crack, or more violently break the glaſs; the tip, at which we had ſealed the bolt-head, was warily taken off; whereupon there ruſhed out a pretty deal of air, with a conſiderable noiſe: and I doubted not that this generated air had been conſiderably compreſt whilſt it was pent up; when caſting my eyes on the liquor, to diſcover what change this eruption had made there, I perceived on the upper ſurface of it, a multitude of ſmall bubbles, ſuch as appear in ſeveral liquors, after the air has been pent up with them, when the glaſſes come to be unſtopp'd. And thus having ſeal'd up ſome ſheeps blood, and kept it for ſeveral days in a gentle warmth; tho' the containing glaſs were far larger than what held our ſerum; yet after ſome time, when no violence was offer'd to it, it was ſuddenly blown up, with a ſurprizing noiſe, by the aerial or elaſtic corpuſcles that were produced, or ſet free by the putrefaction we diſcovered to have been made.

The ſmell of our ſerum was ſtrong, tho' not cadaverous, but rather reſembled that of the tincture of ſulphur, made with ſalt of tartar, and ſpirit of wine; or of ſome ſuch ſulphureous preparation.

And afterwards diſtill'd.

One principal view I had in keeping our ſerum ſo long ſealed up, was, to try, whether by a digeſtion, or putrefaction, for ſome months, it would, like urine, afford a ſaline ſpirit, or an alkali, volatile enough to aſcend before the phlegm. And committing it to diſtillation, in a ſmall glaſs head and body, in a digeſtive furnace, being careful to take the firſt ſpoonful of the ſpirit that paſs'd into the receiver, we found, that tho' this liquor, at firſt, ſmell'd ſtrong, yet the taſt was not at all briſk, nor ſpirituous, like that uſually obtained, by diſtillation, from putrefied urine. Nor did our liquor, when dropt into ſyrup of violets, preſently give it any manifeſt greenneſs. Yet becauſe I found it n[illegible]pid, I thought fit to examine it a little farther, and dropp'd a convenient quantity of it into a clear and ſtrong ſolution of ſublimate, in common water; by which means there was produced a whiteneſs, like that which ſpirit of urine, or volatile ſalt, would have made. And by this I was invited to mix ſome of it with a little ſyrup of violets, upon a piece of white paper; and alſo to wet with the ſame liquor, ſome ſmall filings of copper, ſpread upon another piece of paper; and to leave them both, all night, in the open air, that the liquor might have time to work upon the ſyrup and the metal. And we found in the morning, that the former was turn'd green, and the latter ſo far diſſolved, as to leave a large bluiſh ſtain upon the paper.

The near relation that, according to ſome phyſicians, there is between milk, and the more ſerous part of the blood, cauſed me to try, whether the ſerum of human blood would grow red, by being kept continually ſtirring over a moderate heat, with a competent quantity of ſalt of tartar; but in two trials we found not any redneſs produced; tho' one of them was made in a veſſel of refined ſilver, with an eighth part of the ſalt, to one of the ſerum; which was the ſame proportion we had uſed, when the experiment ſucceeded well in milk.

An attempt to turn the ſerum red.

It may be needleſs to take notice, that the ſerum of human blood will, by heat, be in a ſhort time coagulated into a kind of gelly; or rather, as far as I have obſerved, into a ſubſtance like a cuſtard, as to conſiſtence, tho' not as to colour. Having found that acid ſpirits, alſo, would coagulate ſerum, I thought fit to try, whether alkalies would not oppoſe, or retard its coagulation; and putting ſome ſpirit of human blood to a convenient quantity of ſerum, and cauſing them to be kept ſtirring over a very gentle fire, tho' the volatile alkali did not hinder the coagulation, yet it ſeemed to make it both more ſlow, and more ſoft. And this effect was yet more conſiderable, when we try'd another parcel of ſerum, with ſalt of tartar, inſtead of ſpirit of blood.

How ſerum is affected by alkalies and acids.

Human urine being obſerved, when frozen, to have, on the ſurface of the ice, figures reſembling combs or feathers; the great affinity generally ſuppoſed betwixt urine and the ſerum, made me try, at once, whether the latter would freeze with ſuch a degree of cold, as would eaſily congeal water; and whether, in caſe it ſhould freeze, the ice would have a ſurface figured like that of frozen urine. But having for this purpoſe expoſed ſome ſerum of human blood to the cold air, in two freezing nights ſucceſſively, the ſerum was not found to congeal; yet I ſcarce doubted, but an exceeding hard froſt would have produced, at leaſt, a thin plate of ice, upon the ſurface of our liquor. And to confirm this conjecture, we took the ſame ſerum, and having ſtrained it thro' a linen cloth, to ſeparate the liquor from any clotted or fibrous parts, we put it into a ſhallow concave glaſs, and laid that

How by congelation.

upon ſome of our frigorific mixture of ice a[illegible]lt; by which means, the ſerum being frozen from the bottom upwards, there appeared, here and there, upon the ice, contiguous to the air, certain figures, reſembling thoſe of frozen urine.

And how made to ſerve for an inviſible ink.

Having obſerved, that human urine would tolerably ſerve for what is call'd an inviſible ink; and conſidering the great affinity that is ſuppos'd to be between urine and the ſerum of blood, I thought fit to try, whether the latter might not be employed, like the former, to make a kind of inviſible ink. To this effect, we took ſome ſerum of human blood, and having dipt a new pen in it, we trac'd ſome characters upon a piece of white paper, and ſuffered them to dry thereon; we then held the unwritten ſide of the paper over the flame of a candle, by which means, the written letters appeared on the upper ſurface of the paper, tho' not of an inky blackneſs, yet of a colour dark enough to be eaſily legible, and very like to ſome others, that having been purpoſely written with freſh urine, and made viſible by heat, were compared with them. *

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* Dr. *Freind*, in mixing the following liquors with the ſerum of human blood, obſerved, that each of them turn'd it of a different colour; but that they, ſeverally, gave it a greater degree of fluidity, which continued for a day or two. The liquors were a tincture of aloes, made with mint-water, a decoction of ſavin, ſavin-water, ſpring-water, the decoction of gentian, arum, ſarſaparilla, and china; ſpirit of ſal-armoniac, and of tartar, oil of caraway-ſeeds, *Jones*'s panacea of opium, *Sydenham*'s liquid laudanum, ſpirit of ſaffron, and of turpentine, *Tinctura martis tartariz.* ſpirit of guaiacum, ſpirit of hartſhorn, and the oils of turpentine, guaiacum, lavender, and cloves. He further found, that a decoction of the *Peruvian* bark rendered the ſerum much more fluid than any of theſe liquors; that ſpirit of wine, with camphire, ſtrongly coagulated it; and that after they had, for ſome time, remain'd together in the vial, there was a large ſediment at the bottom; the upper part of the liquor appearing clear and tranſparent; that rectified ſpirit of wine kept it turbid, without any precipitation; that the tinctures of ſcammony, caſtor, amber, ſulphur, and *Peruvian* bark, moderately coagulated the ſerum; that the tinctures of ſaffron, and of metals, the *Poteſtates ſuccini*, and *Sal. vol. oleoſ.* afforded a light coagulum, and the *Tinct. mart. Mynſie*, a ſtrong one; a concreted maſs, like gum, falling to the bottom; that the diaphoretic tincture of antimony render'd it turbid, and a little concreted; that the tinctures of jalap, and of amber, with ſal-armoniac, render'd it only turbid; and, laſtly, that the tinctures of *Spec. diambr.* and cochineal, made with ſpirit of wine, afforded ſcarce any coagulum. See *Freind. Emmenolog. p.* 162, 163.

The decoctions of pomegranat-ſhells, tormentil, and biſtort, being ſeverally put to ſome ſerum of human blood, cauſed it to concrete a little. Tincture of coral coagulated it. Spirit of ſalt concreted a ſmall part of it; but left the other thin and liquid. Spirit of nitre made a ſtrong coagulum; but half the ſerum remain'd fluid. The ſame happened with *Spir. nitri bezoartic.* Oil of vitriol precipitated a coagulum; leaving ſome part liquid. The *Tinct. antiphthiſica* made it turbid, and ſomewhat concreted it. *Aqua fortis*, and *Spir. vitriol. philoſ.* gave a white coagulum. *Aqua ſtyptica* made a very ſtrong concretion. The tincture of *Terra Japon.* gave a red coagulum. A ſolution of ſalt, in common water, made a white concreted maſs; as did, alſo, a like ſolution of nitre. *Emmenolog. p.* 177, 178.

MEDICINE.

SECT. III.

HAVING, for want of materials, been reduced to treat the hiſtory of human blood in ſo very imperfect a manner, as to leave many of the primary heads untouched, and others but ſlightly ſpoken to; I ſhall here, by way of ſpecimen, branch one of the primary heads into its ſeveral parts, and treat of each diſtinctly. And ſince the ſpirit of human blood, is one of the nobleſt of urinous or volatile alkalies; ſo that moſt of the things that ſhall be taught concerning it, may, with ſome little variation, be applied to ſpirit of urine, hartſhorn, ſal-armoniac, ſoot, &c. I ſhall make choice of that; and give a kind of ſummary of the hiſtory of volatile ſalts, in general. But it will here be neceſſary to take notice, firſt, that the ſpirit I employed in making the following tryals and obſervations, was drawn from human blood, without any ſand, clay, or other addition, except ſome vinous ſpirit to preſerve it; and that the firſt diſtillations were performed in retorts plac'd in ſand; care being taken that the veſſels were not near filled: becauſe blood, if it be not well dry'd, is apt to ſwell much, and paſs into the neck of the retort, if not into the receiver. Secondly, that the blood we made uſe of, was drawn from perſons who parted with it out of cuſtom. And, laſtly, that there being ſo great an affinity between the ſpirit and volatile ſalt of human blood, that, probably, the latter is little other than the ſpirit in a dry form, and the former than the ſalt united with phlegm enough to give it a liquid form; 'tis preſumed, that it may be allowable to conſider the volatile ſalt of blood as its dry ſpirit.

Subordinate heads for the hiſtory of the ſpirit of human blood.

1. *The ſeveral ways of diſtilling human blood.*
2. *Whether human blood may be ſo ordered, by fermentation or putrefaction, that, in diſtillation, a ſpirit, either urinous or vinous, may aſcend before the phlegm.*
3. *Whether ſpirit of human blood be really any thing but the volatile ſalt and phlegm, well commixed.*
4. *The ſpecies of ſaline bodies, to which ſpirit of human blood is to be referr'd.*
5. *Whether ſpirit of human blood differs from ſpirit of urine, and other ſpirits that are called volatile alkalies.*
6. *The quantity of ſpirit contained in human blood; whether accompanied with its ſerum, or dried.*
7. *The ſpecific gravity of ſpirit of human blood.*
8. *The odour, taſte, colour, tranſparency, and conſiſtence of the ſpirit of human blood.*
9. *The ſolutive power of the ſpirit of human blood.*
10. *The tinctures that may be drawn with ſpirit of human blood.*
11. *The coagulating power of the ſpirit of human blood.*
12. *The precipitating power of the ſpirit of human blood.*

13. *The affinity between ſpirit of human blood, [illegible]me chymical oils and vinous ſpirits.*
14. *The relation between ſpirit of human blood and the air.*
15. *The hoſtility of ſpirit of human blood with acids, whether in the form of liquors, or of fumes.*
16. *The medicinal virtues of ſpirit of human blood, outwardly applied.*
17. *The medicinal virtues of ſpirit of human blood, inwardly uſed, in pleuriſies, head-achs, coughs, fevers, the ſcurvy, cachexies, dropſies, fits of the mother,* &c.
18. *Particulars omitted, and promiſcuous experiments, and obſervations, concerning the ſpirit of human blood.*

The ſeveral ways of diſtilling human blood.

Obſerving that ſeveral bodies, when diſtill'd with quick-lime, afford liquors different from thoſe they would have yielded, if they had been diſtill'd either *per ſe*, or with ſome vulgar addition, we took five ounces of concreted, but not dry'd human blood, and having mixed it with an equal weight of quick-lime, we diſtill'd it, by degrees of fire, in a retort plac'd in ſand, and thereby obtain'd a large proportion of a reddiſh ſpirituous liquor, not conſiderably phlegmy, together with ſome oil, very ſmall in quantity; the reſt being probably kept back by the lime: and of this little oil, there was a ſmall portion that ſunk in the ſpirit; the reſt ſwimming upon it.

The ſpirit, being put into a ſmall head and body, was ſet in a digeſtive furnace to rectify, at leiſure, with a very gentle heat, and the receiver was three or four times ſhifted, that we might obſerve what difference there would be betwixt the ſucceſſive portions of liquor. The firſt that came over, did not ſmell near ſo rank as that diſtill'd *per ſe*. This obſervation belongs, alſo, to the three or four ſucceeding portions of liquor: probably, becauſe the lime had better freed the ſpirit of the firſt diſtillation from the fetid oil; many of whoſe particles are apt imperceptibly to mix with it, when drawn over without addition. The rectified ſpirit, which was clear and colourleſs, had a taſt much ſtronger than its ſmell; for a ſmall drop of it upon the tongue, had ſomething of a firyneſs that was ſurprizing, and laſted longer than one would wiſh; which made me doubt, whether the ſpirituous part of the blood had not carried up with it, ſome of the firy parts of the quick-lime: whence one wou'd expect ſome uncommon effects from ſuch a ſpirit, which, in this caſe, would be enriched with a kind of volatalized alkali; a thing much deſired by many chymiſts and phyſicians. Upon this ſuſpicion, we dropt a little of it into a ſtrong ſolution of ſublimate, in fair water, when it ſeem'd, at the firſt contact, to make a precipitate a little enclining to yellow; tho' afterwards the precipitate appeared white, like that made with ordinary volatile liquors of an urinous nature.

But expecting that our alkaline ſpirit of blood, ſo I call it, would have ſome peculiar qualities, differing from the ſpirit, drawn without ad-

addition; I thought fi[illegible] make a few trials with it, whoſe event juſtify'd my conjectures. For, having put ſome of it, well rectify'd, into a glaſs egg with a ſlender neck, it did not then afford any volatile ſalt in a dry form; (tho' afterwards, by another trial, we at length obtained a little) and having continued the trial ſomewhat obſtinately, we found the ſpirit, by the action of the fire, to have become muddy.

Having mixed another portion of it with highly rectified ardent ſpirit, and kept them all night in the cold, no coagulation enſued; nor could we perceive any, after it had been kept, for ſeveral hours, in a moderate heat. But the mixture acquired a yellow colour, and let fall a pretty deal of darkiſh powder.

We put to another parcel of our ſpirit, ſome good ſpirit of ſalt; but tho' they ſmoak'd much at their meeting, yet we obſerved no noiſe, nor bubbles, upon their mixture. And having united another portion with oil of vitriol; tho' there was produced a very great ſmoke, and an intenſe degree of heat, yet there was no viſible ebullition, nor any noiſe, or bubbles produced, but the colour of the oil of vitriol was very much heightened; the mixture growing almoſt red.

From theſe and the like phenomena we may gather, that our alkalizate ſpirit of blood differs, in ſeveral particulars, from the ſimple; and may, probably, be very conſiderable, both as a medicine and a menſtruum.

We took two ounces of tartar, calcined to whiteneſs by an equal weight of kindled nitre, and mingled this alkali with two ounces of dry'd human blood, in powder. This mixture being diſtilled in a retort, in a ſand furnace, made it appear by its productions, that quicklime, on theſe occaſions, acts differently upon the blood from other alkalies. For the diſtillation wherein lime was employed, afforded us a ſpirit, that, before rectification, was very ſtrong, and unaccompanied with dry ſalt; but the calcination of nitre and tartar, afforded us, at the very firſt diſtillation, a ſpirit leſs ſtrong, but ſo much volatile ſalt as covered almoſt all the inſide of the receiver; and tho' the ſtrong ſaline ſpirit of blood, made with quick-lime, would not make an effervescence with acid ſpirits, yet this volatile ſalt readily did, upon the affuſion of ſpirit of ſalt.

Beſides the fixt alkaline addition, with which I diſtilled dry'd human blood, I added to it that very acid one, oil of vitriol; for I had found by trial, that this liquor being mixed with other bodies, particularly ſome belonging to the animal kingdom, did, in an odd manner, unite its own ſubſtance with them, and notably diverſify the products of the diſtillation. We put, therefore, upon three ounces of powder'd human blood, an equal weight of oil of vitriol, and left them for ſome time together, to try if by the action of this corroſive menſtruum, a heat would not be excited; and, accordingly, we found, that after a while, the mixture grew ſenſibly warm. Then we removed the retort into a ſand-furnace; and di[illegible]g by degrees of fire, we had a ſpirit which was preceded by a pretty deal of phlegmy liquor, of an odd ſulphureous ſmell, but ſurprizingly ſtrong and laſting. It ſeemed remarkable, that, notwithſtanding the great acidity of oil of vitriol, and the fixing power it exerciſes on many bodies, wherewith it is committed to diſtillation, our experiment afforded us a conſiderable quantity of volatile matter, in the form of a white ſalt; but the ſmell and taſt of it were very uncommon.

Whether human blood may afford, by diſtillation, a ſpirit, urinous or vinous, before the phlegm.

By what I have yet tried, I am not much encouraged to expect a vinous, or ardent ſpirit from human blood, tho' that be the uſual product of fermentation in liquors; and the leſs, becauſe I am not ſure that there is any fermentation, truly and properly ſo called, in human blood, either within or out of the body; having never found any thing in the blood or urine, which convinced me, that either of them would afford an ardent ſpirit.

I once kept human blood for a year together, in a glaſs, hermetically cloſed, with a deſign to try, whether any ſpirits would firſt aſcend; but when the blood came to be expoſed to the air, the ſcent of it was ſo offenſive, that we were obliged to have it haſtily thrown away. Another time, having cauſed ſome ſheeps blood to be digeſted, in a large vial hermetically ſealed; after it had long continued in the digeſtive furnace, it, upon a ſudden, broke with a ſurprizing noiſe, and blew off the long neck of the vial. Two or three like miſchances I had, in attempts made on human blood. But this ill ſucceſs did not hinder me from attempting ſomething of the like kind; and looking upon the ſerum of the blood, as the likelieſt part of it to concur to a proper fermentation, we put to ſome ounces of it, about a fourth part of raiſins well bruiſed, and kept them in a glaſs, whereof a conſiderable part was left empty; and having cloſed the veſſel, we ſet it in a warm room; and within a few days the raiſins began to emerge, and afterwards continued to float; and there was produced a conſiderable quantity of permanent and ſpringy air. Which phenomena ſeemed plainly to argue, that there had been ſome degree of fermentation produced in the mixture; yet when we came to diſtil the ſerum, thus alter'd, tho' it did not ſmell as if it had putrefied, yet the liquor that firſt aſcended, even with a gentle heat, did not taſt or ſmell like a vinous ſpirit; tho' it differed from meer phlegm. I, likewiſe, tried, with the ſerous part of the blood, whether it would by digeſtion, or putrefaction, be ſo opened, as, when diſtill'd, to let the ſpirit aſcend before the phlegm; and having kept a quantity of this ſerum above four times as long as is ſufficient to make urine, in diſtillation, part with its ſpirit before its phlegm, we diſtill'd it with a very gentle fire, that few or none beſides the fugitive parts, might at firſt aſcend. But we found the liquor that came over, to have but little ſtrength, either as to ſmell or taſt; nor did it readily turn ſyrup of violets green, tho' after ſome hours ſtanding together, it would; yet as a volatile alkali, it preſently turned a ſtrong ſolution, made of common ſublimate in fair water, into a white, opake, and almoſt milky liquor.

Whether ſpirit of human blood be any thing but the volatile ſalt and phlegm united.

What has hitherto occurred to me, inclines me to think, that the ſpirit of human blood is totally compos'd of volatile ſalt and phlegm, tho' not, perhaps, pure and unmixed; for when the ſpirit, volatile ſalt, and oil, are ſeparated from it by diſtillation and ſublimation, as far as is uſual in chymical preparations of volatile alkalies, the remaining liquor, which paſſes for phlegm, will yet be impregnated with ſome particles of oil, and ſometimes a few of volatile ſalt, that are too minute to be diſtinguiſhable by the naked eye. But whether frequent rectifications may ſo accurately ſeparate theſe heterogeneous parts, as perfectly to free the aqueous ones from them, and thereby reduce the phlegm to ſimple, or elementary water, I leave undetermined. And the rather, becauſe, by frequent diſtillations, ſome particles of the fire may, poſſibly, from time to time, ſubſtantially be aſſociated with thoſe of the liquor; and even in the firſt diſtillation of human blood, the fire may have either ſeparated, or produced a liquor, that, tho' almoſt ſtrengthleſs, and not juſtly referable to any of the received principles, or ingredients, oil, ſalt, and earth, is not yet phlegm, truly ſo call'd, but a neutral liquor, which woods, and many other bodies, afford by diſtillation, that is neither acid, nor alkalizate, nor true phlegm.

But as a compoſition may be diſcovered, perhaps better by producing, than by reſolving it; we diſſolved in diſtill'd water as much volatile ſalt of human blood, as the liquor would take up; and then having carefully diſtilled it in a conveniently ſhaped veſſel, with a regulated degree of heat, the diſtillation afforded us a liquor, that, by its ſmell, taſt, and operations, appeared to be a good briſk ſpirit of human blood. And this experiment was repeated with the like ſucceſs.

The ſpecies of ſaline bodies, to which the ſpirit is referable.

'Tis well known, that of late, ſaline ſpirits obtained by diſtillation, have been obſerved to be of two ſorts; the ſaline ſpirits that aſcend in diſtillation, are ſome of them acid in taſt; as ſpirit of nitre, ſpirit of vitriol, *&c.* and ſome have taſts like common ſalt, or like lixiviate ſalts; but their difference is greater in their operations than their taſts; for being put together, there will preſently enſue a manifeſt conflict between them, and uſually the one will precipitate the bodies that the other hath diſſolved. 'Tis neceſſary to add, that among the ſalts called alkalies, ſome are fix'd in conſiderable degrees of fire, and others not; for which reaſon many modern chymiſts and phyſicians, who take acid and alkali for the true principles of mix'd bodies, call the one fix'd, and the other volatile alkalies. And ſince the names fix'd alkalies, and volatile, are now much in requeſt, I ſhall ſometimes uſe them in the vulgar acceptation.

This being premis'd, I ſay, the ſpirit of human blood is to be referred to that ſpecies of ſaline bodies; becauſe tho' the ſpirit of blood be a liquor, yet its more efficacious operations ſeem totally to depend upon the fugitive ſalt wherewith it abounds. We know, that ſome volatile ſalts, which riſe even in a dry form, may not be of an alkalizate, but acid nature; and not only *Helmont* and his diſciples, but a great part of the modern chymiſts and phyſicians, alſo, aſcribe digeſtion to an acid ferment, or menſtruum in the ſtomach; whence it ſhould ſeem, that acid corpuſcles may paſs into the maſs of blood, and impregnate it. But notwithſtanding this, the ſpirit of human blood is manifeſtly referable to that claſs, which many call volatile alkalies (and I often term urinous ſpirits); for I find ſpirit of blood capable of effecting thoſe things, the performance of which has been look'd on, almoſt ever ſince I propoſed them, as the touch-ſtone to know volatile alkalies, and diſtinguiſh them from the other ſorts of ſaline bodies; for it will make a great conflict with acid ſpirits, as ſpirit of ſalt, *Aqua fortis*, &c. it immediately turns ſyrup of violets into a fair green; 'twill precipitate a ſolution of ſublimate, in common water, into a white powder; and, in ſhort, produce thoſe other effects that may be expected from true volatile alkalies.

If, indeed, I were ſure, digeſtion was performed by an acid ferment or juice, whenceſoever the ſtomach is furniſh'd with it, I ſhould ſuſpect that ſome acid particles may be mixed with the blood. But that would not hinder me from referring the ſpirit of human blood to volatile alkalies; becauſe ſo few acid particles would be either deſtroy'd by the alkalizate ones, that ſo abound in the ſpirit; or at leaſt theſe would be ſo very predominant, as might well allow us to give their denomination to the mixture. Thus, if a few drops of ſpirit of vinegar were mixed with ſome pints of ſtale urine, they would either be deprived of their acidity, by ſome corpuſcles of a contrary nature, that they meet with in the liquor; or be ſo obſcured and overpowered by the fugitive ſalts it abounds with, that the acid particles would not hinder the ſpirituous liquor, drawn from the mixture by diſtillation, to be juſtly referable to the claſs of volatile urinous ſalts.

Whether it differs from ſpirit of urine, and other volatile alkalies.

It ſeems hard to determine, whether there be any difference betwixt the ſpirit of human blood, and other volatile alkalies; becauſe two bodies may agree in many qualities, and, perhaps, in all the moſt obvious; and yet on ſome third body, or in ſome caſes, manifeſt diſtinct powers, and have their peculiar operations.

But there may be a great difference between volatile ſalts and ſpirits, as they are ordinarily prepared for medicinal uſes, and as by repeated rectifications, and other ways of depuration, they may be brought to a greater ſimplicity or purity. And whether the ſpirit of human blood, and other liquors abounding, like it, in volatile alkalies, reduced to as great a purity, as they can, by art, be brought to, would be altogether alike in their nature and qualities, or no;

yet, if we conſider them in that ſtate, wherein they are thought pure enough for medicinal uſes, and, accordingly, are employed by phyſicians and chymiſts; there is, very probably, ſome difference between the ſpirit of human blood, and other volatile alkalies; and particularly thoſe afforded by urine, and by hartſhorn. For tho', to me, the bad ſmells of all theſe liquors, ſeem to be much alike, yet ſeveral ladies, and thoſe of very different ages, affirm, they find a manifeſt difference between theſe ſmells, and abhor the odour of ſpirit of blood, tho' they will, with pleaſure, long hold their noſes over the ſpirit of hartſhorn, and even that of ſal-armoniac; and affirm themſelves to be much refreſhed by it. And tho' with ſpirit of urine, or ſal-armoniac, joined in a due proportion with ſpirit of ſalt, I have uſually been able to make a ſalt, that ſhoots into the peculiar figure of ſal-armoniac; a figure very different from that of ſea-ſalt, nitre, *&c.* yet I have ſeldom, if ever, obtained a ſalt of that ſhape, by the mixture of the ſpirit of human blood, with that of common ſalt; for tho' their ſaline corpuſcles, upon the evaporation of the ſuperfluous moiſture, would coagulate together, yet the concretion ſeem'd confuſed; and either all, or a great part of it, was deſtitute of that neat and diſtinct ſhape, I had ſeveral times obſerved in concretions, made by the mixture of the ſpirit of ſea-ſalt with urinous ſpirits. And as to the medicinal virtues of ſpirit of blood, *Helmont* tells us, there is a conſiderable difference between the ſpirit of human blood, and that of urine; ſince, according to him, the ſpirit of human blood cures epilepſies; a thing the ſpirit of urine will not do.

The quantity of ſpirit contained in human blood, accompanied with its ſerum, or dry'd.

'Tis not eaſy to determine the exact proportion of that liquor, which, when by diſtillation obtained from human blood, the chymiſts call, its ſpirit, with regard to the other principles, or ingredients, whereof the blood conſiſts. For ſome mens blood may be much more phlegmy or ſerous, than that of others; which it ſelf may be more or leſs ſpirituous, according to the complexion, age, ſex, *&c.* of the perſon. But twelve ounces of healthy human blood, afforded us ſeven ounces and an half of phlegm; and, conſequently, about four ounces and an half of dry matter. And having committed to diſtillation, in a retort, and a ſand furnace, ſeven ounces of well dry'd blood, we obtained about ſeven drams of ſpirit; to which, tho' it were not rectified, that name may well be given, becauſe it was ſo very rich in ſpirituous and ſaline parts, that it left in the receiver, and in the containing vial, a large quantity of volatile ſalt undiſſolved; which a phlegmy liquor would not have done: and if ſpirit of blood be only ſalt and phlegm united, we may well ſuppoſe, that human blood yields a far greater proportion of ſpirit than this; ſince from the ſeven ounces of our dry'd blood, we obtained about five drams of volatile ſalt; which, if we had, by diſtillation, united with a fit quantity of phlegm, would, probably, have afforded us near two ounces more, of a liquor deſerving the name of ſpirit.

The conſiſtence and ſpecific gravity of the ſpirit of human blood.

I found that a compact body weighing fifty-eight grains, in the air, and in water ſix grains, and three fourths, weighed in rectified ſpirit of human blood but five grains, and one fourth. And notwithſtanding the volatility of our ſpirit of blood, I found that a large piece of amber, being put into it, did not fall to the bottom of the liquor, but kept floating at the upper part of it; and if plung'd into it, would emerge.

One might expect a manifeſt degree of tenacity in the ſpirit of human blood, becauſe, among many modern chymiſts, it paſſes for an alkali; and we know that ſeveral other alkalizate liquors, as oil of tartar *per deliquium*, fixed nitre reſolv'd the ſame way, ſolution of potaſhes, *&c.* are ſenſibly unctuous, and but languidly fluid; yet I did not obſerve, that ſome rectified ſpirit of human blood, tried between my fingers, did feel more unctuous than common water. And as thoſe who ſell brandy, or ſpirit of wine, uſually ſhake it, till it afford ſome froth, and then by the ſtay this makes on the ſurface, judge of the tenacity or tenuity of the liquor; eſteeming that to be the moſt unctuous, whereon the bubbles make the longeſt ſtay, and *è contrà*; I thought fit, by the ſame method, to examine ſpirit of human blood; and found, that the froth would laſt very little on the ſurface of it; the bubbles breaking or vaniſhing, almoſt as ſuddenly as if the liquor had been good ſpirit of wine. I, likewiſe, obſerved, that when I warily let fall of our well rectified ſpirit of blood upon ſome other body, it ſeemed that the ſingle drops were manifeſtly ſmaller than thoſe of water, and of ſeveral other liquors, would have been.

Its ſubtilty and activity.

Becauſe it may be of ſome importance, to know how ſubtile the active parts of ſpirit of human blood are, and how diſpoſed or fitted to diſperſe or diffuſe themſelves through other liquors of convenient textures; we ſo prepared common water by infuſions, made in it without heat, that by putting one ſingle drop of our rectified ſpirit of human blood into four ounces, and four ſcruples of the prepared water, and lightly ſhaking the vial, there appeared through the liquor a manifeſt colour, whereof no degree at all was diſcernible in it juſt before: which ſufficiently argues a wonderful ſubtilty of parts in the ſpirit we employ'd; ſince a ſingle drop of it could diſperſe its corpuſcles through, and unite with two thouſand times as much water; and yet retain ſo much activity, as to make their preſence not only ſenſible, but conſpicuous, by a manifeſt change of colour which they produced. This computation, indeed, is made, upon ſuppoſition, that a drop of water weighs about a grain, and that a drop of our ſpirit of blood was of the ſame weight with a drop of water.

The former ſuppoſition is commonly made; and tho' I have not found it to be exactly true; (for a drop of water weighs more than a grain;) yet this difference is much more than recompenſed by that we found between the weight of a drop of water, and the weight of one of ſpirit of human blood. For having, in a very good balance, let fall ten drops of common water, and as many of our rectified ſpirit of human blood, we found, as we might well expect, that a drop of the ſpirit, as it was manifeſtly leſs, ſo it was far lighter than a drop of water; whence the whole ten drops did not amount to four grains; ſo that we may ſafely judge the drop of ſpirit to have manifeſtly diffuſed it ſelf, and acted upon above four thouſand times ſo much water in weight, (and perhaps in bulk too;) ſince, indeed, the proportion extended a conſiderable way towards that of one to five thouſand; and may, therefore, be ſaid to be as that of one to between four and five thouſand. And yet a conſiderable part of the ſingle drop I employed was phlegm, uſeleſs to the change produced; the effect being wholly due to the ſaline ſpirit of the little ſingle drop.

Its heat, and coldneſs.

The ſpirit of human blood is, with regard to ſome liquors, potentially cold, ſince it refrigerates them; and in reference to others, potentially hot; ſince being mix'd with them, the mixture becomes actually hot.

Into a ſlender cylindrical glaſs we put the lower part of an hermetically ſealed thermometer, and into the ſame glaſs poured as much moderately ſtrong ſpirit of blood, as would cover the ball of the thermometer; when, dropping on this liquor ſome good ſpirit of ſalt, there was produced a conflict, accompanied with noiſe, bubbles, and a heat, that ſuddenly made the ſpirit of wine aſcend above two inches and a half. This experiment is the more conſiderable, becauſe there are many volatile alkalies that, being confounded with acid ſpirits, tho' they ſeem to make a true effervescence, yet really produce a notable degree of coldneſs. And tho' I have, ſeveral times, found, that the ſpirit of verdigreaſe would, with volatile ſalt of ſal-armoniac, or of urine, produce a ſeeming effervescence, but a real coldneſs; this ſpirit of verdigreaſe, being mix'd in the foreſaid ſmall cylindrical glaſs, with but moderately ſtrong ſpirit of blood, did not only produce a hiſſing noiſe, and numerous bubbles, but an actual heat, whereby the ſpirit of wine in the thermometer was made quickly to aſcend above an inch and a half; tho' the liquors employed amounted not, both together, to two ſpoonfuls.

Having into a wide-mouth'd glaſs put as much ſpirit of blood, as would more than cover the ball of a ſmall ſeal'd weather-glaſs, and ſuffered this inſtrument to ſtay there a while, that the ambient liquor and the included might be reduced to the ſame temper, as to heat and cold; we poured on ſome ſpirit of verdigreaſe made *per ſe*, and obſerved, that tho' this ſpirit, with ſome other volatile ſaline liquors, had a very differing operation, yet working with our ſpirit of blood, with which it made a conflict and excited bubbles, there was produced in the mixture a degree of warmth, ſenſible on the outſide of the glaſs; but it was much more ſenſible in the thermometer, the liquor whereof aſcended to a conſiderable height above the former ſtation,

to

towards which, when the conflict of the two liquors was over, it began, tho' ſlowly, to return.

Since ſeveral ſalts, both volatile and fixed, being powder'd and put into water, will, whilſt they are diſſolving, ſenſibly refrigorate it; and on the other ſide, ſince ſome very ſubtile ſpirit, actually cold, being put into cold water, will quickly produce in it a ſenſible warmth, I thought proper to try, what the ſpirit of human blood would do, when employ'd after the ſame manner. Having, therefore, placed a ſealed thermometer in an open mouth'd glaſs, furniſhed with as much diſtill'd water as would cover the ball of the inſtrument, we left it there for a while, to bring the internal liquor and the external to the ſame degree of coldneſs: then we poured upon the immerſed ball two or three ſpoonfuls of ſpirit of human blood, but perceived no alteration in the thermometer, unleſs the ſpirit of wine in the ſtem ſubſided a very little.

Its ſolutive power, and balſamic virtue.

We took crude copper, in filings, and having poured on it ſome highly rectified ſpirit of human blood, we ſhook them together, and in about a quarter of an hour, or leſs, perceived the menſtruum to look a little bluiſh; and this colour grew gradually higher, till after ſome hours the menſtruum had diſſolved copper enough to make it deeply blue. In ſome circumſtances the ſpirit of blood has a ſurprizingly ſudden operation upon copper. For having made a coined piece of that metal clean and bright, and put a drop or two of our ſpirit upon it; within about half a minute, the verge of the moiſtened part of the ſurface appeared bluiſh, and preſently after, the reſt of the wetted part acquired a fine azure colour.

We alſo took filings of zink, or ſpelter, and having poured on them very well rectified ſpirit of blood, we obſerved, that, even in the cold, it quickly began to work manifeſtly, tho' not vigorouſly thereon. But being aſſiſted with a little heat, it diſſolved the zink briskly, and not without producing numerous bubbles.

I took a piece of coagulated blood, but not dry'd, ſomewhat bigger than a large pea, and cut from the lower part of the lump, that it might be black. This clot we put into a ſlender vial of clear glaſs, that the colour might the better be diſcerned, and then poured upon it a little rectified ſpirit of human blood, and ſhook the glaſs a little; whereupon the colour of, at leaſt, the ſuperficial part of the blood, was, in an inſtant, manifeſtly changed; the blackneſs quite diſappearing, and being ſucceeded by a very florid colour, like that of fine ſcarlet. The liquor, alſo, was tinged, but not with near ſo deep or ſo fair a red; and by the little bubbles, which, from time to time, paſt out of the clot, it ſeemed to work ſomewhat like a menſtruum. Yet ſoon after, coming to look upon this lump of blood again, I found it to have much degenerated from its natural colour, to one leſs fair and more dark.

We took alſo another clot of blood, like the former, only one part of it, which had lain next the air, was not black; and having, in a vial like the former, poured on it ſome ſpirit of blood, taken out of the ſame vial, whence I took the firſt parcel, the reddiſh colour ſeemed preſently to be much improved, and made more fair, and like true ſcarlet. But the black was not aboliſhed, but changed dark and dirty.

Twelve drams of human blood were put up into a bolt-head, with two drams of ſpirit of human blood; and after they had ſtood together for above twelve months, they appeared, through the glaſs, of a fine florid colour, and ſeemed to be little leſs than totally fluid. And, indeed, when we came to open the veſſel, which was carefully ſtopt with a good cork, and hard ſealing wax, we found no ill ſcent, or other ſign of putrefaction in the mixture, and but a very ſmall portion of blood lightly clotted at the bottom; ſo that the ſpirit of human blood ſeems to have a great embalming virtue; ſince it was able for ſo long and ſo well to preſerve ſix times its weight, of a body ſo apt to concrete and putrefie, as human blood is known to be; and, probably, would have preſerved it much longer, if we had thought fit to proſecute the experiment. Upon diſtilling this mixture with a very gentle heat, the firſt liquor that aſcended was not a ſpirit, but a kind of phlegm; tho' afterwards there came up, beſides a ſpirituous liquor, a volatile ſalt, in a dry form.

We took a clot of human blood, of the bigneſs of a bean, and having put it into a vial, ſo that the part which before was contiguous to the air, was now the undermoſt; and the other, which was blackiſh, lay now the uppermoſt; we immediately poured upon it as much ſpirit of human blood, as was more than ſufficient to cover it; and perceived, that the contact thereof preſently began to leſſen the blackneſs of the ſurface of the blood, and bring it to a conſiderable degree of floridneſs: and to try whether that would continue, we ſtopp'd the vial, and ſet it by till next morning, when looking upon it, we found the ſuperficial colour not to be black, but ſtill red.

Upon the powder of dry'd human blood, we put, in a ſmall vial, ſome of the rectified ſpirit of human blood, which quickly diſſolved part of it, and acquired a deep and pleaſant colour: but highly rectified ſpirit of wine being put upon ſome of the ſame powder, in a like glaſs, did not in many hours acquire any manifeſt tincture; and got but a pale yellow one, even after having been for a longer time kept in a moderate heat: yet common water being put upon another portion of the ſame powder, quickly appeared, by the colour it acquired, to have diſſolv'd a pretty deal of it.

Some of our ſpirit of human blood, being put upon two parcels of curious vitriol, that I had as a rarity from the *Eaſt-Indies*, one whereof was in lumps, and the other beaten to powder; the liquor being able to diſſolve the former but ſlowly, made little or no froth; but the ſpirit upon the latter working haſtily, produced a manifeſt one. And the ſolutions made of both parcels, were of a deeper and more lovely blue, than the mineral it ſelf. Nor did I obſerve in them any precipitate of a dark colour, as I have done upon the mixture of ſpirit of urine, and ordinary vitriol.

On freſh filings of iron, we poured ſome of our ſpirit, and having kept them a while together in digeſtion, we found that the liquor had wrought on the metal, and produced a conſiderable quantity of a light ſubſtance, in colour almoſt like the *Crocus*, but ſomething paler. There alſo appeared in the liquor many thin plates, like a kind of *Terra foliata*, which after a very ſlight agitation, being held againſt the ſun-beams, exhibited the colours of the rain-bow, in a very vivid and ſurprizing manner: but I did not perceive that the taſt of the liquor was conſiderable ferruginous.

Having with a clean pen drawn ſome letters upon white paper, with ſpirit of human blood, and, as ſoon as 'twas dry, mov'd the unwritten ſide over the flame of a candle; we found that this liquor may be employ'd as an inviſible ink; and it ſeemed to be ſomewhat better than thoſe afforded by ſerum and urine.

What tinctures may be drawn with ſpirit of human blood.

Spirit of blood being put upon *Engliſh* ſaffron, ſoon acquired a fine yellow colour.

The ſame put upon powder'd turmeric, did, in the cold, extract from it a lovely tincture, like a rich ſolution of gold; which, probably, may prove a good deobſtruent medicine, particularly in the jaundice.

Upon fine powder of human blood, we put ſome moderately ſtrong ſpirit of the ſame ſubject, on which the liquor began very ſoon to colour it ſelf, even in the cold; and within no long time after, appeared as red as ordinary *French* claret. This extract made me ſuſpect, that the phlegm, which was not carefully ſeparated from the ſpirit I then employed, might haſten the colouration of the menſtruum. For which reaſon, I put upon another portion of the ſame powder, ſome rectified ſpirit of blood, ſo well dephlegmed, that it would not diſſolve a grain of the volatile ſalt of blood; and found that this menſtruum did not any thing near ſo ſoon draw a tincture, as the other had done; for after ſeveral hours, the colour it had obtained was but brown; tho', after ſome hours more, the colour appeared to be heighten'd into a redneſs; yet manifeſtly inferiour to that of the phlegmy ſpirit, whereto it did, however, in a longer time grow almoſt equal. By this means we may not only diſguize the ſpirit of blood, but impregnate it with the finer parts of the unanalyzed ſolid body, which may, poſſibly, make the ſpirit a remedy more proper for ſome diſeaſes, or conſtitutions: and this medicine I ſometimes call the entire tincture of human blood.

But to ſhew that the ſpirit of human blood may extract tinctures out of ſome of the hardeſt bodies, I made the following experiment.

We took ſome choice filings of ſteel, and having put them into a ſmall glaſs-egg, we poured on them ſome highly rectified ſpirit of blood, and kept them all night in digeſtion with a moderate heat. The next day we found the menſtruum turn'd of a deep browniſh red colour; and ſome of the filings, that chanced to ſtick to the ſides of the glaſs, ſeemed to have been, either by exhalations from the menſtruum, or, perhaps, by the tranſient contact of it, as it was pouring in, turn'd into a kind of yellow *Crocus martis*. Having kept the menſtruum and the filings together, in the ſame egg, for ſome days longer, the colour was grown opake, and appeared to be black, when viewed in any conſiderable bulk: but it had another appearance, when thin ſpread upon white paper.

Suſpecting that our ſpirit would work upon ſteel, in another manner than common acid ſolvents, we poured ſome of the tincture, drawn from filings of ſteel, upon a freſh tincture of galls in common water, but did not find that this liquor would, with the infuſion, make any inky mixture; nor that the precipitate, which was quickly produced, was of a black, much leſs of a true inky colour.

I put ſome ſpirit of human blood upon fine powder'd amber, and kept them in digeſtion for ſome days, giving a moderate degree of heat; but we obtained not any conſiderable tincture: perhaps the ſpirit was not yet highly enough rectified, or the amber not ſo proper to yield its tincture, as I have ſeveral times found the courſer and deeper coloured ſort to be.

Having put ſome ſpirit of human blood upon ſeed-lac, tho' this be a reſinous gum, and of no eaſy ſolution, the ſpirit ſoon became tinged, as I expected, becauſe I conjectured, that the redneſs apparent in many of theſe grains, is but ſuperficial, and proceeds from ſome adhering blood of the little inſects, that by their biting occaſion the production of this gum, upon the twigs of the tree where the lac is found. So that the tincture ſeems not to be drawn from the lac it ſelf, but rather to be afforded from the blood of theſe little animals, which the ſpirit of human blood, that will draw tinctures from dry'd man's blood, diſſolves: and this tincture may, probably, be a good medicine; ſince moſt of the inſects uſed in phyſic, as millepedes, bees, &c. even in our colder climates, afford remedies of very ſubtile and piercing parts, and of conſiderable efficacy.

The coagulating power of it.

I have found, by trial purpoſely made, that the highly rectified ſpirit of human blood, being well mixed, by ſhaking, with at leaſt an equal part of vinous ſpirits, which wou'd burn all away, there will preſently enſue a coagulation or concretion, either of the whole mixture, or a great portion of it, into corpuſcles of a ſaline form, that cohering looſely together, make up a conſiſtent maſs, tho' very ſoft: and in this form it may remain, as far as I have yet try'd, for, perhaps, ſeveral months, or weeks at leaſt, if it be kept in a cool place.

In a froſty ſeaſon we expoſed, late at night, two or three ſpoonsfull of ſpirit of human blood, being but moderately ſtrong; and tho' the cold of that ſeaſon had throughly frozen a vial almoſt full of oil of vitriol; and the night wherein our ſpirit was expoſed, was moderately froſty, yet the next morning we did not find ſo much as any ſuperficial ice upon it: but having removed the vial into a mixture of powder'd ice, and common ſalt, we found, in no very long time, that moſt part of the ſpirit was turned into thin plates of ice, which join'd cloſe together, and had their edges upwards, like thoſe of the leaves of a book, when held with its back downwards.

Its precipitating power.

Of the precipitating power of ſpirit of human blood, I have yet obſerved nothing peculiar; but, as far as I have had occaſion to try, it has, in common with thoſe other volatile ſpirits which I call urinous, a power of precipitating moſt bodies that are diſſolved in acid menſtruums.

I have made trial upon red-lead, diſſolved in the acid ſalt of vinegar, ſilver in *Aqua fortis*, gold in *Aqua regia*, and tin in an appropriated menſtruum. I, alſo, with our ſpirit, precipitated the ſolutions of ſeveral other bodies; and, particularly, out of a ſolution of common ſalt, made in common water, we could readily precipitate with the ſpirit of blood, a ſubſtance that looked like a white earth: and ſuch a ſubſtance I obtained, in far greater quantity, from that which the ſalt-makers call bittern; which uſually remains in their ſalt-pans, after they have taken out as much as would coagulate in figured grains.

The ſpirit of human blood in part precipitates *Dantzick* vitriol diſſolv'd in water.

We attempted to make *Aurum fulminans*, by precipitating a ſolution of gold, made in *Aqua regia*, with ſpirit of human blood; by dulcifying the precipitate with common water, and then drying it leiſurely; and ſucceeded in the attempt.

The affinity between ſpirit of human blood, ſome chymical oils, and vinous ſpirits.

There ſeems, in the popular ſenſe of the word, to be an affinity between rectified ſpirit of human blood, and pure ſpirit of wine; ſince we have obſerved, that, being put together, they will readily coagulate, and continue united for a long time. And, it is very probable, that the like aſſociation may be, alſo, made with other ardent ſpirits, prepared by fermentation.

We have, likewiſe, formerly noted, that our ſpirit will make a ſolution of the finer parts of human blood well dry'd; which ſeems to be the effect of ſome affinity or congruity between the ſpirit and the body it works on; becauſe a highly rectified vinous ſpirit would not, that I could ſee, draw any tincture from it.

With lixiviate liquors, ſuch as are made of ſalt of tartar, fixed nitre, &c. reſolv'd in the air, or otherwiſe, the chymiſts will expect, that the ſpirit of blood ſhould have an affinity; ſince they eſteem all theſe liquors alkalies; tho' this be volatile, and thoſe be fixed. But tho' theſe liquors comport well with one another, yet we find not that they ſtrictly aſſociate by coagulation, as the ſpirit of blood does with ſpirit of wine.

The ſame ſpirit of blood readily mingles with that ſpirit of vegetables, that I call adiaphorous; which argues, that there is ſome affinity between them, or rather, that there is not any manifeſt hoſtility, or contrariety.

The like relation may be found between ſpirit of blood, and many other liquors; but tho' there is, manifeſtly, a near relation between the ſpirit of human blood and the oil; ſince they both proceed immediately from the ſame body; yet even dephlegmed ſpirit of blood being ſhaken, and thereby confounded with its oil, will quickly ſeparate again; tho' with ſpirit of wine (which is, according to the chymiſts, a liquid ſulphur, as well as the oil) it will permanently unite, notwithſtanding that theſe two liquors belong even to different kingdoms, the animal and the vegetable.

With the eſſential oils of aromatic vegetables, or, at leaſt, with ſome of them, the well rectified ſpirit of human blood ſeems to have a greater affinity. For, having taken a dram of this liquor, and an equal weight of oil of aniſeeds, drawn in an alembic, and ſhaken them well together, they made a ſoft, or ſemi-fluid white coagulum, which continued in that form for a day or two, and, probably, would have longer done ſo, if I had not proceeded further with it.

But ſuſpecting, tho' ſpirit of blood would not totally mix with eſſential oils, it might either communicate ſome ſaline parts to, or work a change in them; I digeſted, for a while, in a glaſs with a long neck, ſome rectify'd ſpirit of human blood, and a convenient quantity of oil of aniſeeds; and found, that the oil grew of a high yellow colour, and afterwards attained to a redneſs: which may, poſſibly, ſuggeſt a hint, as to the cauſe of ſome changes of colour, produced in ſome of the fluids of the body.

Upon the affinity, or congruity of the ſpirit of blood with that of wine, and with ſome eſſential oils, I founded a way of taking off the offenſive ſmell of ſpirit of human blood; which is the only thing that is likely to keep the more delicate ſort of patients from employing ſo uſeful a medicine: but till experience is duly conſulted, I ſhall retain a doubt, whether the way employed to deprive our ſpirit of its ill ſcent, will not alſo deprive it of part of its efficacy. On the other ſide, it's probable, that theſe aromatiz'd ſpirits may, by being impregnated with many of the finer parts of the oils, employ'd to correct their odour, be likewiſe endowed with the virtues of thoſe oils, which are liquors that ſeem to conſiſt of the nobleſt parts of the vegetables that afford them.

To aromatize ſpirit of human blood, we employed two different ways; firſt, we took a convenient quantity of well rectify'd ſpirit of blood, and having put it into a glaſs-egg, we added to it as much, or half as much eſſential oil of aniſeeds, for inſtance, and having ſhaken theſe liquors together, to mix them very well, we plac'd the glaſs, in a fit poſture, in a furnace where it ſhould not have too great a heat; by which means the ſlight texture of the coagulum being diſſolved, part of the oil appeared by it ſelf, floating at the top of the ſpirit; whence, being ſeparated, the remaining liquor was whitiſh and without any ill ſcent; the ſmell predominant in it being that of the aniſeeds, of which it taſted ſtrongly; tho' the ſaline ſpirituous parts of the blood in this liquor retain'd a conſiderable degree of their briſk and piercing taſt.

The other way we uſed to aromatize our ſpirit of blood, was, by employing a medium, to unite it with eſſential oils. For which purpoſe, in a vinous ſpirit, ſo dephlegmed, that in a ſilver ſpoon it would totally burn away, we diſſolved, by ſhaking, a convenient proportion of an eſſential oil; and to this ſolution added a convenient quantity of our rectified ſpirit of blood; and having, by ſhaking, mixed them as well as we could, we ſuffered the expected coagulum to reſt for ſome time; after which it appeared, that ſome of the oil was revived, and ſwam in drops diſtinct from the other liquor, which conſiſted of a mixture of the two ſpirits, impregnated with the particles of the oil they had intercepted and detained. This liquor abounded with little concretions, made by the coagulation of the ſanguineous and vinous ſpirit. And theſe, with a very gentle heat, ſublimed in the form of a volatile ſalt, to the upper part of the glaſs; which ſalt ſeemed to have a leſs penetrating odour, than the meer volatile ſalt of human blood; but had quite loſt its ill ſmell, as had, alſo, the remaining liquor; both being moderately imbued with that of the oil.

I thought it worth trying, whether there was any affinity between our ſpirit and the highly rectified oil of petroleum; and having ſhaken together a convenient quantity of each, in a new vial, they preſently turn'd into a white mixture. And tho', after it had, for many hours, been left to ſettle, the greater part of the oil ſwam above the ſpirit; yet there appeared, betwixt the two liquors, a large quantity of a whitiſh matter, which ſeem'd to be produced by the precipitation or union of many particles of the ſpirit and oil, more diſpoſed than the reſt to combine with one another.

The relation between ſpirit of human blood and the air.

'Tis known that the contact of the air has a manifeſt operation upon extravaſated blood, by changing its colour from black to a florid red, in that ſurface which is expoſed to it. We thinly ſpread, upon a piece of white paper, ſome ſmall filings of copper, and wetted them well, without covering them quite over, with a few drops of good ſpirit of blood; by which means, being very much expoſed to the free air, the action of the liquor was ſo much promoted, that within a minute or two it did, even in the cold, begin to acquire a bluiſh colour; and ſooner than one would have expected, that colour was ſo heighten'd as to become blue. But when I put another parcel of the ſame filings into a vial, and covered them with ſpirit of blood, and then ſtopt the vial, to keep it from the external air, the liquor would not, in ſome hours, acquire ſo deep a colour.

Having, in a clear cylindrical vial, about an inch in diameter, put more filings of copper than were requiſite to cover the bottom, we poured upon them ſo much ſpirit of human blood, as ſerv'd to ſwim a finger's breadth above them. This liquor, becauſe of the quantity of air, contain'd in the vial, did, within few hours, acquire a rich blue colour, which, after a day or two, began to grow more faint, and continued to do ſo gradually till it almoſt vaniſhed; yet the liquor was not altogether limpid, or colourleſs, as I have often had it with ſpirit of urine, or of ſal-armoniac; which remains of bluiſhneſs I attribute to the great quantity of air, included in the vial, with ſo ſmall a quantity of liquor. And tho' I thought it poſſible, that length of time might deſtroy theſe remains of bluiſhneſs alſo, yet, without waiting for that, I unſtopt the vial, and perceived, in about two minutes, the ſurface of the liquor, where it was touch'd by the freſh air, became blue; and perhaps in leſs than a quarter of an hour, the whole body of the liquor had attained a deeper colour than that of the sky; which colour, the vial being ſeaſonable and carefully ſtopt, began in two or three days to grow paler again.

Into a ſlender cylindrical vial we put filings of copper, more than enough to cover the bottom, and then pouring on ſome ſpirit of human blood, till it reach'd about an inch above the filings, we ſtopt the glaſs cloſe; and, as we expected, the menſtruum diſſolved ſome of the metal, and acquired upon it a deep blue colour, which, by keeping the veſſel in a quiet place, for ſome days, by degrees diſappeared, and left the liquor like water. And then the glaſs being unſtopt, there appeared a fine blue ſurface between the confines of the air and the liquor, in a minute or leſs; and this fine colour, extending it ſelf downwards, was, in no long time, diffuſed through the whole body of the liquor; and that ſo plentifully, as to render it almoſt opake. But tho' I kept the glaſs, for many days after, well ſtopt, yet the colour did not diſappear, as was expected, but continued very intenſe.

And having poured ſome of our ſpirit upon well powdered *Lap. Armenus*, the liquor did, even in the cold, and in no long time, acquire a deep and lovely blue, almoſt like the ſolution of filings of crude copper, made with the ſame menſtruum.

I alſo made the like experiments ſucceed, with other ſpirits abounding in volatile ſalts; and, indeed; I found, by a careful tryal, that by means of a volatile ſpirit, made without any ſubſtance afforded from the body of man, I could, with filings of copper, make an experiment very like the preceeding; tho' in this the repeated contact of the air produc'd in the liquor not a blue, but a green colour.

Spirit of vinegar being put upon the florid ſuperficies of a parcel of human blood, very quickly deprived it of its freſh ſcarlet colour; and made it of a dark or dirty one.

The juice of a lemmon ſqueezed upon the florid ſurface of blood, preſently impair'd the colour; but did not appear to alter it any thing near ſo much as the ſpirit of vinegar.

Juice of oranges chang'd the colour of the florid ſurface of blood, leſs than juice of lemmons.

The black or lower part of a portion of human blood, being turn'd uppermoſt, and thereby expoſed to the air, within three quarters of an hour, acquired by the contact of it, a pleaſant and florid colour.

But if upon the black ſurface of the blood ſome good urinous ſpirit were dropt, an alteration would immediately be made; and a pleaſant red colour preſently appear on the ſurface of the blood.

Fixt alkalies, or lixiviate ſalts, reſolv'd *per deliquium*, likewiſe alter'd the black ſuperficies of the blood to a red colour; but not ſo florid or pleaſant as that produc'd by the urinous ſpirit. The freſh juice of the leaves of ſcurvy-graſs being drop'd upon the black ſuperficies of a lump of human blood, ſeem'd preſently to make ſome change in the colour of it, which we judged to be ſomewhat reddiſh, inclinable to florid.

Having, in an unſtopt glaſs, put ſome ſpirit of human blood into a receiver, placed upon our pneumatic engine, and withdrawn the incumbent air by pumping; the ſpirit of blood ſeem'd to afford leſs and fewer aerial bubbles, than ſuch a quantity of common water it ſelf would, probably, have done.

Having unexpectedly found a vial, that was written upon above twelve years before, and inſcribed ſpirit of human blood, it appear'd to have been very looſely ſtopt; yet not ſo, as to give cauſe to think the liquor was much waſted. But it had acquired a deep colour, almoſt like that of red wine, and was ſo diſpirited and ſtrengthleſs, that it appeared to be very little other than nauſeous phlegm. Hence we may gueſs, how little a portion of the noble and genuine ſpirit, or ſalt, may ſuffice to make a liquor paſs for ſpirit of human blood.

The hoſtility of this ſpirit with acids, in the form of liquors and fumes.

That there is in the ſpirit of human blood ſuch a thing as a chymiſt, or a vulgar philoſopher, would call hoſtility, or an antipathy to acids, has been plainly intimated already. I now add, that our ſpirit exerciſes this hoſtility againſt more than one ſort of acid ſpirits; tho' perhaps they differ widely from one another; as ſpirit of ſalt, ſpirit of nitre, ſpirit and oil of vitriol, *Aqua fortis*, *Aqua regia*, &c. and even againſt natural acids too; as I found by the conflict it would make with freſh juice of lemmons, which it would put into a confuſed agitation, accompany'd with bubbles. And this was yet the more evident, when I employed the volatile ſalt of blood; that is, the ſpirit in a dry form: for having ſqueez'd upon a parcel of this, ſome juice of lemmons, there was preſently excited a great commotion, accompany'd not only with froth but noiſe. Nay, further, this hoſtility extends even to the inviſible effluvia of liquors, as appears by putting any ſtrong acid ſpirit, as of ſalt, or of nitre, *&c.* into a wide-mouth'd vial, and ſome well dephlegmed ſpirit of blood into another; for when I purpoſely inclined theſe glaſſes ſo towards each other, that their lips almoſt touched, and their reſpective liquors were ready to run out; tho' neither of the liquors did at all emit viſible fumes, whilſt they were kept aſunder, with their glaſſes unſtopp'd; yet now the fumes, meeting in the air, would make little coalitions, viſible in the form of aſcending ſmoke: and this production of ſmoke would long continue, if the vials were ſtill held near together.

We took ſome pure volatile ſalt of human blood, and having juſt ſatiated it with ſpirit of nitre, we ſlowly evaporated the ſuperfluous moiſture, that the acid and urinous ſalts might be united into a dry concretion; from which my deſign was to ſeparate them again; the ſalt of blood in its priſtine form, and the ſpirit of nitre in the form of ſalt-petre. To effect this, we put the compound ſalt into a ſmall bolt-head, with a long ſlender neck; and then added to it a convenient quantity of ſalt of tartar, and as much diſtilled water, as ſufficed to make the mixture ſomewhat liquid; to promote the action of the contrary ſalts upon one another. By theſe mutual actions we ſuppos'd, that the ſaline ſpirits of nitre, being more agreeable to the fixed ſalt than to the volatile, would forſake the ſalt of blood, and ſuffer it to ſublime; and, accordingly, having kept the glaſs, wherein the mixture was made, for a competent time in a convenient heat, a large proportion of fine volatile ſalt aſcended in a dry form into the neck.

Having put to ſome of the ſpirit of human blood, a ſmall quantity of exceeding ſtrong ſpirit of nitre, there was, upon the conflict of the two liquors, excited ſo great a quantity of thick white fumes, that I could not but wonder at it; having never ſeen any thing of that kind comparable to it. And theſe fumes circulating long in the cavity of the glaſs, whereof, perhaps, a tenth part was full of liquor, did, many of them, tho' the veſſel were wide-mouthed, fall back and run down the ſides of the glaſs into the ſtagnant mixture, as if they had compos'd ſtreams of a milky liquor. And when, at length, after theſe fumes had diſappeared, we dropt in a little more of the ſame ſmoaking ſpirit of nitre, the like ſtrange plenty of white exhalations preſently enſued, and continued to circulate for a great while in the open glaſs; the mixture in the mean time appearing reddiſh. Being ſettled, and ſeeming to have been ſo diſcoloured by a fattiſh ſubſtance, we put to it a little rain, or diſtill'd water; and having by filtration ſeparated it from the feces, and ſlowly evaporated the liquor thus clarified, the ſaline parts ſhot into cryſtals much of the ſhape, and croſſing one another after the manner of *Stiriæ* of ſalt-petre; but their colour, after a while, appeared yellow, as if ſome oily ſubſtance were yet mixed with them.

And tho', on ſeveral occaſions, the ſpirit of blood appeared oily, yet I once had ſome diſtill'd from another parcel of blood, which, after having been kept for a year, was limpid and colourleſs, like an ordinary vegetable ſpirit.

Some of the fore-mentioned cryſtals being put upon well kindled charcoals, preſently melted, and burnt away with a noiſe like that of ſalt-petre; but the flame ſeemed not quite ſo flatulent, and differed in colour; being not at all blue, but very yellow. After the deflagration was quite over, I found an odd fixt ſubſtance left upon the coals; for it was not of a light colour, nor of an incoherent body like aſhes, but a little lump of a brittle, dirty-coloured matter, in which I could not perceive an alkalizate taſt, and, indeed, ſcarce any at all. And this ſubſtance being held in the flame, became red-hot, without appearing deſtroyed, no more than afterwards it did, by being long kept upon a glowing coal.

Having, by degrees, mixed our ſpirit of blood, with as much good ſpirit of nitre as it wou'd manifeſtly work on, there were, with noiſe, produced numerous bubbles; and being kept in a quiet place, till after the liquors had quite ceaſed to work on one another, it began to appear, that notwithſtanding all our care to free the ſpirit of blood from oil, ſomething oleaginous, that had been concealed in it, was partly ſeparated by this operation; ſince not only a reddiſh colour was produced by it, but after a while the ſurface of the liquor was covered with a film; ſuch as I have often obſerved in ſaline liquors greatly impregnated with antimony, or other ſulphureous bodies. And this thin membrane had its ſuperficies ſo diſpos'd, that looking upon it with the eye placed conveniently, it appear'd adorn'd with vivid colours of the rain-bow; and in the ſame order they are ſeen in the clouds.

The medicinal virtues of ſpirit of human blood, externally apply'd.

As far as I have obſerved, we do not regularly meet with any acid ſubſtance (unleſs we except the *Succus pancreaticus*) in a ſound human body; but the ſeveral parts of it, whether ſolid as bones, or liquid as blood, afford in diſtillation plenty of liquor, impregnated with volatile ſalt; whence I am induced to think, that the ſpirit of human blood, wherein ſuch a ſalt abounds, and whereof it is the principal and predominant ingredient, may, probably, have notable operations upon the human body, and afford medicines of great efficacy in many diſeaſes. And tho' againſt moſt of theſe it is to be internally given, yet there are ſome in which it may be ſucceſsful, when but externally adminiſtred. For, ſince well rectified ſpirit of human blood abounds with very ſubtile particles, which, in point of taſt, odour, diffuſiveneſs, and penetrancy, much reſemble thoſe of ſtrong ſpirits of urine, of hartſhorn, and of ſal-armoniac; we may, very probably, expect to find the ſame virtues in the ſpirit of blood, that experience has ſhewn belong to them.

I have ſcarce ever ſeen any medicine operate ſo ſuddenly in hyſteric fits, as a well dephlegmed ſpirit of ſal-armoniac; (which is, in effect, chiefly a ſpirit of urine; a liquor ſeparated from blood) and this by being barely applied to the noſtrils. And even in agonizing perſons, where it could not recover them, it wou'd frequently, for the time, bring them out of their ſwoons, and make them know and underſtand the aſſiſtants, and, perhaps, ſpeak to them too; of which I could give inſtances. A patient of Dr. *Willis*'s, being in an apoplectic fit, was, by the Dr. at his going out of town, committed to the care of a very ingenious phyſician, who complain'd to me, that they could not hope for any ſucceſs of their remedies; ſhe being ſtupid, and having ſhut her mouth ſo cloſe, that they could not get any thing down; upon which I gave him a very ſubtile ſpirit, either of ſal-armoniac, or ſome other volatile and liquid alkali; by applying which to her noſe, the phyſician found he could preſently make her open her eyes, and, in part come to her ſelf; but then ſhe wou'd again, when the glaſs was removed, ſoon relapſe. But having by thoſe frequent viciſſitudes, gained ſome time, and got a medicine for his purpoſe, he then held the glaſs to her noſe long together; by which means ſhe ſo recover'd her ſenſes, that ſhe was prevail'd upon to take the medicine; and tho', afterwards, upon removal of the vial, ſhe returned into a ſenſleſs ſtate, yet by the help of the urinous ſpirit, they kept her alive, till the medicine ſhe had taken began to act, and make a large evacuation; which rouzed her, and, by degrees, relieved her. But in ſuch difficult and deſperate caſes, I am not content that a vial, with a long neck, be held to the noſe, but ſometimes order, that little pellets of lint, or cotton, be dipt into the ſpirit, and thruſt up the noſtrils; the ſame thing I would adviſe, if need ſhould require it, in the adminiſtration of ſpirit of human blood. And as, for external uſes, I make a particular preparation of ſpirit of ſal-armoniac, or of urine, that is more ſtrong and piercing than that prepared in the more ordinary way; ſo to improve our ſpirit of blood, we put to ſome dry'd volatile ſalt of human blood, as much ſpirit of nitre as wou'd juſt ſerve to ſatiate it; and then, by evaporation, obtained an anomalous kind of compound ſalt, which afterwards, becauſe we deſired a medicine in a dry form, we ſublimed from an equal weight of ſalt of tartar; a body fit to retain not only the phlegmy parts, but the oleaginous too, that often lie conceal'd in volatile ſalts and liquors, wherein they do not at firſt appear, and to which the greateſt part of their fetid or offenſive ſmell, may, probably, be imputed: by this means we obtained a dry white ſalt, of a very piercing ſcent. And to bring over the ſaline part of blood, in a liquid form, which, for the uſe of ſmelling, I commonly prefer to the dry; we mixed two parts of dry'd human blood, with three of lime, and then diſtill'd them with a ſtrong fire; whereby we obtained much ſpirit, unaccompanied with any volatile ſalt in a dry form; which ſpirit ſeem'd, even without rectification, to have a ſtronger ſmell, and a more fiery taſt, than other ſpirit of blood, after rectification. And if we had taken more, or ſtronger lime, we ſhould, probably, have had leſs oil, and a more piercing ſpirit; ſince the lime wou'd, probably, have retained moſt of the oil, and, perhaps, all the ſuperfluous moiſture.

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I have, likewiſe, often found, that ſlight head-aches have been cured in leſs than a quarter of an hour, by the bare ſmell of ſome of theſe well depurated volatile alkalies; and have been particularly relieved by that of human blood; very rarely, for theſe many years, uſing any other medicine, to free my ſelf from pains of the head. And even violent and durable pains of that part have been, if not quite removed, yet much leſſen'd by the ſame remedy often repeated; which I have, likewiſe, obſerved to be uſually very effectual in faintings, eſpecially thoſe of hyſterical women, and hypochondriacal men: whence our ſpirit of human blood, which is a liquor that in many qualities manifeſtly reſembles other volatile alkalies, and which, when well freed from its oil, can ſcarce be diſtinguiſh'd from other urinous ſpirits, may, by its odour, be available in the like diſtempers. But for the more delicate patients, the offenſive odour of our ſpirit may be greatly leſſened by long digeſtions, or by repeated, or skilful rectifications, with the addition of high rectified ſpirit of wine, or chymical oils. Thus, a very few drops of true oil of rhodium will, as I have tried, make an ounce of ſpirit of wine ſo fragrant, that this ſolution being ſhaken together with a convenient quantity of well rectified ſpirit of human blood, there will a mixture be made, that I found to have a brisk ſcent; and yet to be finely imbued with the odoriferous particles of the rhodium.

Thus, alſo, the high tincture of amber, taken with ſpirit of wine, may be employed to correct the odour, and increaſe the virtues of ſpirit of human blood. But becauſe it requires ſome skill, and much time, to draw this tincture from crude amber, tho' finely powder'd; I uſed the following quick and eaſy way, to draw a ſtrong tincture from the oil it ſelf: for tho' this oil will not, even by long ſhaking, throughly diſſolve in ſpirit of wine, yet I found, that by well ſhaking thoſe two liquors together, and leaving them to ſettle at leiſure, tho' they would ſeparate into diſtinct maſſes, yet the ſpirit of wine, even in the cold, extracted from the oil a fine tincture, of a high yellow colour, little different from that of the oil it ſelf. Of this tincture I afterwards mixed as much with ſpirit of blood, as ſufficed to obſcure the urinous ſmell, and make that of the oil of amber ſomewhat predominant; and, as we judged, more ſubtile and brisk than it was before.

But, beſides theſe medicinal uſes, that may be made of the odours of ſpirit of blood, ſimple or compounded, it may have conſiderable virtues, apply'd in ſubſtance as a liquor, by way of fomentation, or otherwiſe. Thus the ſpirit of ſal-armoniac has been much commended, for mitigating the ſharp pains of the gout; and is ſaid to have been ſucceſsfully us'd in the eryſipelas. And as our liquor is very ſpirituous and penetrating, and therefore proper to ſtrengthen and reſolve, and alſo of an alkalizate nature, which fits it to mortifie acidities; it ſeems very probable, that by virtue of theſe, and other benign qualities,

lities, it may, by being apply'd in its liquid form, prove ſerviceable in many caſes, where the chirurgeon's, or phyſician's help is required.

The internal medicinal virtues thereof.

As one kind of morbific matter may produce various diſtempers, ſo a ſingle remedy, by being able to oppoſe one or two of the principal ſpecies of morbific matter, may cure different diſeaſes; eſpecially if it be endowed with any variety of active virtues. And, upon this ground, I am apt to think, that the ſpirit of human blood, skilfully prepared and adminiſtred, may be a good remedy in many internal diſorders of the human body. And, indeed, volatile alkalies, in general, have been in *England* ſo ſucceſsfully uſed in phyſic, of late, that I ſee ſmall cauſe to doubt, that they will hereafter be more univerſally eſteemed and employed; and gradually invite phyſicians to prefer them to many vulgar remedies, that, for want of better, are yet in common uſe; tho' they clog or weaken the patient, and want many advantagious qualities that may be found in volatile alkalies. The ſpirit of human blood, in particular, is endowed with various qualities, that are both active and medicinal; it mortifies acid ſalts, which are the cauſes of ſeveral diſeaſes, and, if I miſtake not, of ſome that are not uſually imputed to them. It is a great reſolver, and, therefore, fit to open obſtructions, that produce many diſeaſes; it is diaphoretic and diuretic, and on both theſe accounts aſſiſts nature to diſcharge ſeveral noxious ſalts, and expel many contagious, or malignant corpuſcles, that offend her. It reſiſts putrefaction, and coagulation of the blood, gives it a briskneſs and ſpirituoſity, that promotes a free circulation; by which means it becomes a good cordial, and, probably, an antidote againſt ſome poiſons. It is, alſo, very friendly to the *Genus nervoſum*; and upon that account is likely to be very proper in hyſteric caſes, convulſions, ſome ſort of head-aches, palſies, ſlight apoplexies, ſome kinds of aſthma's, *&c.* It is alſo balſamic, in ſome circumſtances, and may have many other virtues hitherto unobſerved: for a medicine that does not weaken, nor cauſe great evacuations, nor clog the ſtomach, nor is blemiſhed with the exceſs of any manifeſt quality; but has in it ſelf a complex of ſo many uſeful powers, may reaſonably be ſuppos'd available in abundance of diſeaſes; ſo that a large part of thoſe whereto human bodies are liable, may be powerfully oppoſed by ſome of thoſe excellent qualities, which meet in the ſpirit of human blood.

A young lady, in whoſe family the conſumption was an hereditary diſeaſe, was moleſted with a violent and ſtubborn cough, that was judged conſumptive, and look'd upon by her phyſicians as incurable, without a ſeaſonable remove from *London* into the *French* air; but ſhe was already ſo far weakned, and there remained ſo much of the winter, that it was thought ſhe would die before the proper ſeaſon came for her to undertake ſo long a journey. On this occaſion, being ſolicited by ſome friends of hers, to try what I could do to preſerve her; I ſent her ſome ſpirit of human blood, very carefully prepared and rectified; upon the uſe of which ſhe manifeſtly mended, notwith-

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ſtanding the unfriendlineſs of the ſeaſon; ſo that about the end of *February*, ſhe grew able to venture for *Montpellier*; from whence, in autumn, ſhe return'd recover'd. The ſame ſpirit of blood, made very pure and ſubtile, by the help of a lamp-furnace, was the medicine I put into the hands of an ingenious and ſucceſsful phyſician, who complained to me, that a patient had quite puzzled him, and baffled the endeavours of other eminent men. This patient was frequently obnoxious to ſuch violent and tormenting fits of the head-ach, that he could not endure the light; and was offended with almoſt every noiſe or motion that reach'd his ears; whence he was forc'd to give over his profeſſion; but upon the conſtant uſe of the human ſpirit of human blood, he received ſuch relief as made him, with great joy, return to the exerciſe of his trade. And the phyſician, to whom I gave the remedy for him, told me, that the patient having, by our famous *Harvey*'s advice, been uſed to bleed once in two or three months, the phyſician counſelled him, tho' recovered, not abruptly to break off his ancient cuſtom; and the patient thereupon ſent for the ſame chirurgeon who had formerly let him blood; but when this chirurgeon, who knew not what had been done to the patient, came to open a vein again, and perceived what kind of blood it afforded, he was ſo ſurprized, that he ſtopt the operation, and ask'd the man, with wonder, how he came by ſuch florid blood, who uſed to have it ſo bad; adding, that 'twas pity to deprive him of ſo well condition'd a fluid.

The medicinal virtues hitherto mentioned, belong to the ſpirit of human blood, as 'tis pure and ſimple: but 'tis not improbable, that it may acquire other, and perhaps nobler faculties, if it be dexterouſly corrected, diverſified, or united with fit ingredients; that is, in a word, skilfully altered or compounded. Theſe things may be performed ſeveral ways: as, 1. By uniting, by long digeſtion, or frequent cohobations, the ſpirit of human blood, with the oils, ſalt, and phlegm of the ſame concrete, into a particular kind of mixture called *Clyſſus*. 2. By uniting the ſpirit of blood with acids, as with ſpirit of nitre, ſpirit of vinegar, *&c.* and employing theſe mixtures, either in their liquid form, or reduc'd, by evaporation, into cryſtals or other ſalts; and making uſe of theſe, either as they are, or after a kind of analyſis of them. 3. By uniting our ſpirit with metalline ſolutions, as of gold, ſilver, mercury; and with a ſolution of minium, made with ſpirit of vinegar, by the mixture of which liquor with ſpirit of blood, and a ſlow evaporation, I have had many finely figured cryſtals. 4. By diſſolving in ſpirit of blood, carefully dephlegmed, ſulphur open'd with ſalt of tartar: or by diſſolving in it ſome metalline bodies, as copper, zink, and iron; the latter whereof will afford a liquor, very different from other preparations of ſteel uſually made with acids; and may, probably, have ſome virtues diſtinct from thoſe of the known remedies made of that metal.

But, at once to correct, diverſify, and compound our ſpirit, we may add to it, when we well rectified, an equal or double weight of rectified ſpirit of wine. For theſe liquors, being well ſhaken together, will, in great part, coagulate into ſalt, which, with a very gentle heat, will ſublime in a dry form, wherein I found it to have loſt almoſt all its offenſive ſmell. And tho', againſt this way of proceeding it may be objected, that the efficacy of the medicine is, as well as the urinous ſmell, much weakened; yet I found this ſalt to retain a conſiderable degree of quickneſs and penetrancy. And that which our compounded ſalt leaves behind, if it be dephlegmed, may afford no deſpicable liquor, both for medical and mechanical uſes.

And if the more ſimple way of altering the ſpirit of human blood be carried on a little further, by diſſolving in the ſpirit of wine, before the conjunction of the two ſpirits be made, a convenient proportion, as perhaps a twenty-fourth part of an eſſential chymical oil; the volatile ſalt ſublimed from this mixture, will not only be deprived of its ill ſmell, but endow'd with the ſcent and reliſh of the oil; which, by being thus united with a ſalt, very ſubtile and friendly to nature, will leſs over-power and offend the brain and ſtomach, than meer chymical oils; and being aſſociated with ſuch agile and penetrating corpuſcles, may, with them, gain admiſſion into the more inward receſſes of the body, and there exerciſe the virtues belonging to the vegetables that afforded the oils, or at leaſt to the oils themſelves. In this odoriferous aromatic mixture, the oleaginous particles are, by the intervention of the ſaline ones, brought to unite readily with other liquors, and even with aqueous vehicles, and to continue long enough mixed for the patient to take them commodiouſly. And thus there may be a multitude of *Salia volatilia oleoſa*, that is, of pleaſing, ſubtile, and efficacious remedies for inward uſes, prepared; even as many as the phyſician, or chymiſt, ſhall make eſſential oils. And if theſe be drawn from cephalic plants, as marjoram, roſemary, *&c.* or from cephalic ſpices, as nutmegs, cinnamon, *&c.* they will, probably, afford very briſk and grateful medicines, to relieve and comfort the brain and ſpirits, *&c.*

I recommend it to phyſicians to begin the natural hiſtories of the other animal fluids, as the *ſaliva*, *lympha*, pancreatic juice, *&c.* Only having beſtowed much pains upon urine; and thinking it a moſt noble ſubject to work upon; I ſhall here ſubjoin a ſet of titles, which I once drew up for the natural hiſtory of it.

Heads for the natural hiſtory of human urine emitted by healthy men.

1. *The colours of human urine.*
2. *Its taſt.*
3. *Its ſcent, freſh and putrified.*
4. *The heat and cold of human urine.*
5. *The ſpecific gravity of human urine.*
6. *The conſiſtence of it, as to denſity, viſcoſity, &c.*

7. The

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7. *The aerial particles contained in it.*
8. *Whether human urine is a fit liquor for fermentation, properly ſo call'd.*
9. *The difference between freſh and ſtale human urine.*
10. *The fermentation, or putrefaction, of human urine, and the time it requires.*
11. *The ſpontaneous ſeparation of parts in human urine.*
12. *Its vulgar analyſis, by diſtillation.*
13. *Some other ways of diſtilling human urine.*
14. *The proportion of the ingredients of human urine*
15. *The ſpirits of human urine.*
16. *The phlegm.*
17. *The volatile ſalt.*
18. *The fixt ſalt.*
19. *The compound ſalt.*
20. *The ſhining ſubſtances obtainable from human urine.*
21. *The ſalt predominant in human urine.*
22. *The empyreumatical oil, or oils of urine.*
23. *The* mellago *or rob of human urine, and its uſes.*
24. *The* terra damnata *of human urine.*
25. *Some accidental differences of human urine, as 'tis emitted in the morning, at certain diſtances from meals, or after the uſe of certain aliments, or medicines, as ſparagus, turpentine,* &c. *or at differing ſeaſons of the year.*
26. *The affinity of human urine with other bodies, eſpecially the vegetable and mineral.*
27. *The hoſtility of human urine with acids,* &c.
28. *The affinity and difference between urine, blood, gall, milk,* &c. *and other liquors, or animal juices; particularly the compariſon between human urine and that of brutes.*
29. *The mechanical uſes of human urine.*
30. *The chymical uſes of human urine, and its parts, eſpecially as menſtruums.*
31. *The medicinal uſes of human urine, external and internal.*
32. *Particulars omitted, relating to the hiſtory of human urine.*
33. *Promiſcuous obſervations, experiments and inquiries about human urine.*

MEMOIRS

FOR A

NATURAL HISTORY

OF

Mineral Waters.

SECT. I.

THE ſearch into the nature of mineral waters, being uſually confined to very narrow limits; my preſent deſign is, to enlarge the knowledge of the ſubject, by propoſing ſome comprehenſive heads of enquiry about it.

The difficulty of determining the nature of mineral waters.

But I muſt own, that notwithſtanding the ſeveral means I propoſe, of diſcovering the natures, or qualities, of ſuch waters, the ſureſt way of knowing them is, from a long experience of their good and bad effects; for, I queſtion not, that there lie beneath the ſurface of the earth many mineral ſubſtances, ſome fixed, others volatile, ſome hard, ſome ſoft, ſome in the form of liquors, and others in that of fumes, to which the generality of learned men are wholly ſtrangers; and the natures of ſuch as have been rarely ſeen, are ſo little known, that no names are aſſign'd them: whence, of the ingredients we are unacquainted with, the proportions wherein they are mixed may be ſo numerous, and the qualities reſulting therefrom ſo very different from thoſe of the ſeparate ingredients, that the difficulty of expreſly determining the effects of mineral waters, *à priori*, ſeems almoſt inſuperable to human underſtanding.

But this difficulty ought not to make us think, a project for the natural hiſtory of a mineral water uſeleſs. 'Tis no ſmall advantage, to know what particulars are fit for our enquiry; to be furniſhed with a ſet of heads, under which particular experiments and obſervations may be ranged; and laſtly, to be furniſhed with variety of methods to make the proper trials for inveſtigating the nature, or examining the qualities of a water propoſed: ſince the ſubject may hence be viewed on all its ſides; and a conjecture be made, as to what ſaline, or other known minerals, and what quantities of them, impregnate the water; and, conſequently, what effects 'tis likely to produce in human bodies.

The neceſſity there is for it.

As to diſcover the nature of mineral waters, is a far more difficult task than thoſe who have not tried wou'd imagine; we ought to view the ſubject in as many different lights as we can expoſe it to; and take in all the helps to the diſcovery we can; ſince a great many particulars that ſingly, or at the firſt view, ſeem not very pertinent, yet if ſurvey'd in conjunction, and ſkilfully applied, may greatly conduce to the deſired end. And I have here been the larger in my enquiries, becauſe many obſervations have perſuaded me, that phyſicians ought to conſider very well the nature of the waters they preſcribe; to what perſons; for what diſeaſes; and in what manner they employ them. For tho' many look upon theſe waters as ſuch innocent medicines, that if they do no good, they can do no harm; yet the effects which have too often enſued upon the unſkilful uſe of them, eſpecially when long continued, ſhew the drinking of them to be no ſlight thing, that may ſafely be played with: for I have ſeen very great ſervice, and very great miſchief done thereby; and the latter, in particular, ſome time after their operation is thought to be over, and perhaps forgotten.

And I look upon the examination of the properties and qualities of mineral waters, as a thing of the greater importance, becauſe I ſuſpect, upon probable grounds, that by a diligent ſearch there may be diſcovered, both in *England* and other countries, a far greater number of them than is yet imagined, eſpecially ferruginous ones; for by ſome uncommon trials, I have found, that ſeveral minerals, which men either knew not what to make of, or by reaſon of their paſſing under other names, did not ſuſpect to be chalybeate, abounded in parts of that nature. And as our globe is providentially furniſhed with a far greater plenty and variety of iron-ores and minerals, partaking of that metal, which is the moſt uſeful by far to mankind; ſo they are more diſpos'd, than one wou'd expect from ſuch hard bodies, to impregnate liquors, not manifeſtly acid, and that ſeem unlikely to work upon minerals much ſofter than they. To make this probable; upon the minute filings of pure ſteel, we put ſome tincture of galls made with common water, that had been filtred thro' cap-paper; and found, that in leſs than an hour, the tranſparent infuſion of galls was alter'd to a dark, and almoſt inky colour, which it retained even after filtration; and this, tho' the vial that contained it was very ſlender. A like effect was produced by ſmall filings of ſteel, but ſomewhat more ſlowly, in the red tincture of brazil, and alſo in that of log-wood made with common water.

In countries manifeſtly abounding with metalline and other minerals, it may, perhaps, be worth while to deſcend much lower than the ſuperficies of the ground, to make ſearch after ſubterraneal ſprings and wells, and their operations upon human bodies. For I have been aſſured by thoſe who had viſited mines, that ſometimes, at very great depths therein, they have found running, as well as ſtagnant water, of different taſts and qualities; and that the diggers, venturing to make uſe of them, diſcover'd ſome to be miſchievous, and others innocent and medicinal. Of both theſe ſorts we have inſtances in our tin-mines of *Cornwal*; and as to the latter, an ingenious gentleman, who has the over-ſight of ſome *Corniſh* water-works, tells me, that, in the bottom of a tin-work, called *Karnkey*, wrought above ſixty fathoms deep, the mineral was a mixture of tin and iron, and the water red and thick, yet drank cool and pleaſant, and paſs'd by urine near as red as it was drank; "as I have been informed," ſays he, "by thoſe who uſed it whilſt "the mine was working; but the vein of ore is now degenerated or loſt."

SECT. II.

Heads for the natural hiſtory of a mineral water, conſidered in its channel or receptacle.

HE who wou'd draw up the hiſtory of a mineral water, to have its qualities examined or diſcover'd, ſhou'd, in my opinion, make three ſorts of obſervations about it. And firſt, upon thoſe particulars that relate to it, whilſt yet under ground, or in its native receptacle; next upon its properties, and qualities, when drawn up at the ſpring-head, or other receptacle; and laſtly, upon the operations and effects of it in the human body, both diſtemper'd and in health, according to the ſeveral methods and circumſtances of its adminiſtration. To the firſt of theſe obſervations, the following heads are referable.

1. *In what climate and parallel, or in what degree of latitude, the mineral water ſprings up, or ſtagnates.*

2. *Whether the ſpring-head, or other receptacle, chiefly regards the eaſt, the weſt, the north, or the ſouth.*

3. *Whether the water be found in a plain, or a valley; and if not, whether it riſes in a hillock, a hill, or a mountain.*

4. *Whether it be found at the top, the middle, or the bottom of the riſing ground.*

5. *Whether the water leaves any recrement, or unuſual ſubſtance, upon the ſtones, or other bodies, that lie in the channels it paſſes through, or in the receptacles that contain it.*

6. *Whether there lie beneath, or near the medicinal water, any ſubterraneal fire, that hath manifeſt chimneys, or vents, and viſibly by night only, or by day, burns, or ſmoaks, either conſtantly, or at certain periods.*

7. *Whether at, or near the mouth of theſe vents, there be found either flowers of brimſtone, a ſalt like ſal-armoniac, or other mineral exhalations, in a dry form.*

8. *Whether there be under, or near the courſe, or channel of the water, any ſubterraneal eſtuary, or latent maſs of hot, or viſibly burning materials: and whether ſuch eſtuary afford an uniform heat, as to ſenſe; or have hot fits, as it were periodically; and if ſo, whether theſe come at certain and ſtated times, or irregularly.*

9. *Whether over the eſtuary, or in ſome other part, near which the mineral water ſprings, there ariſe any viſible mineral fumes, or ſmoke, early in the morning, or late in the evening; and if ſuch fumes aſcend, in what plenty, of what colour and ſcent.*

10. *What is the more obvious nature of that part of the ſoil, which appears not manifeſtly metalline, or marcaſitical, and which the medicinal water paſſes through, or touches upon: and what are the qualities of the neighbouring ſoil, and the adjacent country; as whether it be rocky, ſtony, clayiſh, ſandy, chalky,* &c.

11. *Whether there be any ores, marcaſites, or earths, eſpecially high-coloured ones, impregnated with mineral juices, to be met with in the courſe of the medicinal ſpring, or in the receptacle of the ſame water: and what theſe minerals are, whether copperiſh, ferruginous, marcaſitical,* &c. *and whether the ores do, or do not abound in the metalline portion; as, alſo, with what other ingredient, as ſpar, cauke, ſulphur, orpiment, arſenic,* &c. *they are mix'd or incorporated with.*

12. *Whether the ſpring of the medicinal water, was common water, before it came to any particular part of the ſoil it runs through, and there begins to be manifeſtly impregnated with mineral bodies.*

13. *And whether, in this caſe, it makes any efferveſcence, or other conflict, with the mineral it imbibes, or with any other water, or liquor, that it meets with in its way; and whether the conflict produce any heat or no.*

14. *Whether, if the mineral water be manifeſtly hot, or extraordinarily cold, the ſpring it flows out at, or the receptacle it ſtagnates in, have near it a well of water, of a contrary quality; as is obſerved in a few places of* France, *and elſewhere.*

15. *Whether, when the water appears in the ſpring, or receptacle, there float at the top, lie at the bottom, or ſwim between both, any drops, or conſiderable quantity of oil, like* Naphta, *or other bituminous, and inflammable ſubſtance.*

16. *Whether the water be conſiderably alter'd, in quantity or quality, by the different ſeaſons of the year; by the varying temperatures of the air, as to heat, coldneſs, drought,* &c. *by the plenty or paucity, frequency or unfrequency of falling rains, or ſnows; and what may be the bounds, or meaſures of theſe alterations in the water.*

The effects of rain upon a mineral ſpring.

'Tis known, that the drinking of ferruginous waters, ſuch as the *German-Spaw*, and of *Tunbridge*, is uſually preſcribed for many weeks; during which time it often happens, that the fall of rains occaſions a doubt, whether they be not ſo much diluted thereby, as to be ſpoil'd in their medicinal capacity: and, indeed, I more than once obſerved, that ſome ſuch waters, after conſiderable rains, have loſt their power of producing the uſual colour with galls; and, therefore, it may, in ſome caſes, prove very ſerviceable, to be able to conjecture, whether or no the rain has made the mineral water unfit for drinking. Now, a ſmall rain does little or no harm to the medicinal ſpring; and ſometimes, a moderate one, eſpecially after a long drought, may, inſtead of weakning, increaſe its virtue, by waſhing down into its channel ſome ſalts, that, during the dry weather, were concreted in the pores of the ground; and, perhaps, alſo, by raiſing the water in the channel, ſo as to diſſolve ſome ſalts concreted there, which it cou'd not reach before. But if the rain has long continued, the eſtimate may beſt be made, partly by the greater or leſſer depth of the ſpring, below the ſurface of the ground; but chiefly by the peculiar nature, or ſtrength, of the mineral water. For, ſome ſprings are much more copiouſly impregnated than others; and therefore will bear a greater dilution by rain water. Thus, tho' I have found more than one of our *Engliſh* ferruginous ſprings, eſpecially thoſe near *London*, too much weakned by the water that rain'd into them; yet upon carefully trying, how much of that fluid ſome *German-Spaw* water, which came very well conditioned to *London*, wou'd bear, it appeared, that when this was diluted with no leſs than thrice its weight of rain-water, it ſtill retained ſtrength enough to produce a purpliſh colour, with freſh powder of galls.

17. *Whether any thing, conſiderable, can be certainly diſcovered, or any very probable conjecture made, of the nature and qualities of the ſubſtances that impregnate the water, by a chymical and mechanical examination of the mineral earths, through which it flows, or in which it ſtagnates; and, particularly, from obſerving their colour, whether native, or acquired, by being kept in the fire; their ſpecific gravity; their affording, or not affording any ſalt, or other ſoluble ſubſtance, by decoction; their being ſoluble, or indiſſoluble, in particular chymical menſtrua of ſeveral ſorts, as* Aqua fortis, *ſpirit of ſalt,* &c. *and their being committed to diſtillation, in veſſels of different ſorts, and various degrees of fire, with care to receive, ſeparately, the different ſubſtances they afford, whether in the form of liquors, or of flowers; and by examining theſe ſubſtances in proper methods, as alſo their* Caput mortuum, *by calcination, lixiviation, and, if it will bear ſuch a degree of fire, vitrification.*

SECT. III.

Mineral waters conſider'd out of their ſpring.

WE are next to conſider the water, as drawn out of its ſpring, or receptacle: and to render the following heads more intelligible, inſtructive, and uſeful, I will illuſtrate and explain ſeveral of them; and alſo deliver ſome practical ways of tryal, as the ſubjects ſhall require.

1. *Its actual coldneſs or heat.*

The heat or coldneſs of a mineral water, what it denotes, and how it is to be eſtimated.

The knowledge of the degree of coldneſs in the water, eſpecially if it be extraordinary, may lead one to conjecture, whether the ſpring aſcends from any conſiderable depth under ground, or whether it runs through a ſoil abounding with ſalt-petre, ſal-armoniac, or ſome ſuch very refrigerating ſubſtance.

The degree of the water's coldneſs or heat may be eſtimated ſeveral ways; as by its having or not having the power to coagulate eſſential oil of aniſeed or fennel-ſeed; by its being, or not being able to melt bodies, of different diſpoſitions to fuſion, as butter, tallow, bees-wax, *&c.* to coagulate the whites of eggs, or dreſs them in their ſhells, *&c.* but the beſt method is to plunge into the water the globulous part of a good hermetically ſealed thermometer, whereon the degrees of cold and heat are carefully mark'd.

2. *Its ſpecific gravity.*

The advantages of knowing the ſpecific gravity of a mineral water.

The knowledge of the ſpecific gravity of a mineral water may be of great uſe to diſcover its nature; not only by enabling men to diſtinguiſh that from other waters, but by affording a conſiderable and double information. For by comparing the weight of the propoſed liquor with that of common water, we may, in caſe the former proves the heavier, be aſſiſted to eſtimate with what proportion of ſalt, ferruginous, or other mineral ſubſtance, it is impregnated; and if it be very light, or lighter than common water, it may, with probability, be concluded, that the ſubſtance that impregnated it, is either very ſmall in quantity or proportion, but of a ſpirituous and volatile nature; which is a diſcovery of no ſmall moment in this affair. And tho' it may ſeem a paradox, that the water impregnated with a metalline or mineral ſubſtance ſhould be lighter than common water; yet upon tryal, carefully made, I have found ſome mineral waters, as particularly that of *Tunbridge*, that of the *German-Spaw*, and of ſome of the *Iſlington* ſprings, to be manifeſtly lighter than common water: and ſome taken up at *Tunbridge*, has prov'd lighter than common water, purified by diſtillation.

Yet I would not in all caſes refer this ſurprizing levity to the admixture of lighter corpuſcles; becauſe ſome tryals have convinc'd me, that much of the comparative lightneſs proceeds from the mineral waters poſſeſſing a ſmaller quantity of common ſalt than ordinary water contains. My experiments, however, did not ſatisfie me, that this want of ſalt was the ſole or adequate cauſe of the lightneſs of the waters I examined.

The method of determining it, ſhewed by examples.

But to diſcover ſuch minute differences, requires exact inſtruments; and, indeed, to ſpeak freely, there are few upon whoſe reports I durſt confidently relie for the ſpecific gravity of mineral waters. To weigh liquors with accuracy, more care and ſkill muſt contribute with nicer inſtruments than often fall to one man's ſhare. And yet when phyſicians, or others, weigh mineral waters, they uſually do it in an apothecary's ſhop. The moſt accurate method, that I am acquainted with, to compare the different weights the ſame ſinking body has in common water, and in the liquor propos'd, requires skill in hydroſtatics, as well as good inſtruments, and is practicable by few. The way of comparing waters by the greater or leſſer degree of ſubmerſion of the ſame cylinder, or other floating body, is ſcarce accurate enough; wherefore, I choſe to make uſe of a very thin round vial, with a flattiſh bottom, that it might ſtand upright, and be very light, which was furniſhed with a neck as long as a gooſe's quill, drawn very even into a hollow cylinder of above three inches long, and fitted at the top with a little gap, to hinder the water from aſcending above the due height.

This glaſs contain'd three ounces, a half, and forty-three grains of common water, yet, when empty, weigh'd but ſix drams, and forty-two grains; whence I cou'd uſe it, in ſuch a balance, that the addition or detraction of half a grain, or leſs, would make either ſcale preponderate; ſo that, tho' capable of holding water enough for accurate tryals, yet when filled, 'twas not too heavy for a tender balance. In this veſſel, therefore, we carefully weigh'd ſeveral liquors, and among others, different mineral waters; ſome of which we found as follows; the glaſs being always fill'd to the ſame height, and weighed in the ſame balance.*

		oz.	*dr.*	*gr.*
Common water	Weighed	3	4	43
Common water diſtill'd		3	4	41
Acton water		3	4	48½
Epſom water		3	4	51
Dulwich water		3	4	54
Stretham water		3	4	55
Barnet water		3	4	52
North-hall water		3	4	50
German-Spaw water		3	4	40
Tunbridge water		3	4	38
Iſlington water, from the muſic-houſe		3	4	36
Iſlington water, from the vault with ſteps		3	4	39
Iſlington water, from the cellar		3	4	39

From hence is may appear, that as ſeveral mineral waters, which contain ſalts, are conſiderably heavier than common water; ſo ſome, eſpecially ferruginous waters, are impregnated with ſuch a fine ſubſtance, as to be lighter than common water.

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* Water will have different denſities, according as the warm or cold air affects it; whereby a mineral water may be conſiderably influenced, if carried far from the ſpring, before 'tis examined. See *Philoſ. Tranſ.* N°. 315. *p.* 269.

3. *Its tranſparency, muddineſs, or opacity.*

4. *Whether the mineral water will, by ſtanding, let fall, of it ſelf, any oker, or other earthy ſubſtance, eſpecially if the liquor be kept from the air.*

The natural precipitate of a mineral water, to what diſcoveries it may lead.

This article may frequently help to diſcover what kind of ſoil the water has paſſed through, and is alſo uſeful to diſtinguiſh the ſpontaneous reſidence that the liquor lets fall by mere ſtanding, from that they call the *Caput mortuum*, which remains after the total evaporation of the water; by which means, alſo, the weight of the latter may be more truly known. Not to mention other mineral waters, I found ſome from the *German-Spaw*, brought very well ſtopp'd, to *London*, afforded, by long ſtanding, a pretty quantity of terreſtrial ſubſtance, that look'd almoſt like yellow oker, and perhaps was greatly allied to it in nature. The article mentions if the liquor be kept from the air, becauſe I have found that ſome liquors, by being expoſed to the free air, wou'd have copious and ſurprizing ſubſtances ſeparated from them, as if the air contain'd ſome precipitating ſalts fit to work on the fluids.

Microſcopical obſervations to be made upon mineral waters.

5. *Whether any thing can be diſcovered in the mineral water, by means of the beſt miſcroſcopes, well adapted to view it.*

Having cauſed a young perſon, who was uſed to microſcopical obſervations, to look upon ſome mineral waters through the beſt glaſſes; he could diſcern no difference between them and common water. But notwithſtanding this, the tryal ought to be repeated by various perſons, on ſeveral waters, with different microſcopes, in differing lights.

'Tis thought by ſeveral ingenious perſons, that the little bodies diſcovered by Mr. *Leeuwenhoeck*, and ſince by others obſerved in pepper-water, are not living creatures, but little inanimate concretions caſually form'd and carried up and down in the liquor. But the following experiment ſhews the contrary. Having laid upon the microſcope part of a drop of water, wherein I ſaw numberleſs particles in brisk motion, we then put to that liquor with a briſtle, part of a drop of ſpirit of ſalt, which, as we expected, preſently deprived them of their motion, and left them to be carried ſlowly to and fro in the liquor; ſo as to make it viſible that they were then dead, and were alive before.

6. *Its colour.*

7. *Its odour, whether acetous, vinous, ſulphureous, bituminous,* &c.

Various odours obſervable in different mineral waters.

The odours of ſeveral mineral waters are beſt judged of at the ſpring-head, or other receptacle, whence ſome of them being remov'd, ſcarce afford any odour at all, perceptible by us.

Perhaps the ſulphureous ſcent that is ſometimes perceiv'd in *Tunbridge* and other waters, in their ſources, may, in part, proceed from looſe exhalations that caſually happen to be mixed with, but do not conſtantly belong to the water.

The vinous odour is mentioned among others, becauſe I am credibly informed, that in *France* there is a mineral ſpring of that ſcent.

I mention the bituminous odour, diſtinct from the ſulphureous, becauſe men are too apt to confound them, and take all fetid mineral waters for ſulphureous; tho' ſeveral of them are manifeſtly bituminous, as may be gather'd not only from their proper odours, but from ſome drops of petroleum, that are found ſwimming upon the water.

It ſeems, alſo, not unlikely, that ſometimes a ſpring may partake both of ſulphur and bitumen, mix'd together by the ſubterraneal heat; for I have found, that I could eaſily melt and incorporate theſe two ſubſtances

8. *Its taſt, whether acid, ferruginous, vitriolate, lixiviate, ſulphureous,* &c.

9. *Whether any change will be produced in the tranſparency, colour, odour, or taſt of the mineral water, by its being taken up at the ſpring-head, or other receptacle, or removed to ſome diſtance; by its being kept ſtopt or unſtopt, for a greater or leſſer ſpace of time; by its being much heated, or refrigerated, and, alſo, by its being turned into ice by cold, naturally or artificially produced, and thawed again.*

The alterations cauſed in mineral waters by tranſportation, and being expoſed to the air.

This is a neceſſary article, becauſe many perſons who drink mineral waters, cannot well, either for want of ſtrength, or conveniency, repair immediately to the ſpring-head, but are obliged to drink them in their beds, or lodgings, and, perhaps, to have them tranſported from a foreign country. Many purging waters are found to retain their laxative virtue, and that, perhaps, for a conſiderable time, tho' carried to places diſtant from thoſe they riſe in. In ſuch ferruginous waters as are lighter than common water, I found a manifeſt difference with regard to their tranſportation; for moſt of them, even ſuch as will bear removing, have ſomething of freſhneſs and quickneſs at the ſpring-head, that they afterwards loſe. And ſome do not only loſe their briſkneſs by being removed, tho' in veſſels cloſe ſtopt, but alſo the power of producing, with the powder of galls, a purple colour; as I found by trials purpoſely made, in more than one of theſe mineral waters; which, to prevent fraud, I ſent for to the ſprings themſelves, by ſervants of my own; who, tho' they carried glaſs-bottles along with them, and had no other errand but to fill and ſtop them carefully, yet by their bringing them leſs than a league, I found them ſo alter'd, as no longer to afford a purpliſh colour, with powder'd galls, but a deep reddiſh one; whilſt the *German-Spaw* waters almoſt conſtantly, here in *London*, afforded with the ſame powder, a rich purple colour: and *Tunbridge* waters gave the like, but not ſo deep, when I received them at *London* very well ſtopt; which is a circumſtance of great moment. For, more than once, I have received at *London*, waters ſent me by phyſicians from *Tunbridge*, which yet wou'd, by no means, yield with galls a purpliſh colour. And I found, that even the *German-Spaw* water wou'd ſoon loſe its faculty of turning purpliſh by galls, if it were conſiderably heated. But the ſame *Spaw* water being, in the ſummer-time, kept all night in an open veſſel, did, till late the next morning, retain a diſpoſition to be made purple, by the admixture of galls; but it loſt that diſpoſition before the next day.

10. *The thinneſs, or viſcoſity of the mineral water.*

11. *Whether the water be more eaſily heated and cooled, dilated and condenſed, than common water.*

12. *Whether the mineral water will, of it ſelf, putrefy; and if ſo, whether ſooner or later than common water; and with what kind, or degree, of ill ſcent, and other phenomena.*

13. *The change of colours producible in it by aſtringent drugs, pomegranate peels, balauſtians, red roſes, myrobalans, oak leaves,* &c. *as alſo by ſome juices of the body.*

Remarks upon the common methods of examining mineral waters by galls.

Since the change of colour that mineral waters produce in the infuſion, or tincture of galls, is the moſt uſual, and almoſt the only way whereby phyſicians examine them; I ſhall ſet down ſome remarks which I have made about this method of proof; and the rather, becauſe it may, *mutatis mutandis*, be uſefully applied, to find the qualities of mineral waters, by colourations made with other materials. Firſt then, it may be obſerved, that an infuſion, or tincture of galls in common water, is not neceſſary to try if a new colour will by them be produced. I uſually keep their powder in a glaſs, exactly ſtopt, to have them in readineſs to mix with the water, and ſo alter its colour immediately, if galls will do it; for to draw the tincture of galls with ſimple water, often takes up ſeveral hours; and the tinging parts are, alſo, much weakned by being diluted. But if a tincture be required, the powder of galls tied cloſe up in a rag, and hung in the liquor, makes the infuſion leſs muddy.

I have obſerved thoſe parts of the infuſion of galls, eſpecially when made by heat, that produce the new colour with ferruginous waters, are very apt to fly away; the infuſion often becoming unfit to alter the colour of the waters, whilſt it ſelf appears high-coloured. Upon which account, I chooſe to make the tincture of galls a little before I uſe it; or if I employ dry galls, to take powder that is not ſtale.

'Tis no ſafe way, and may prove very erroneous, to mix galls, or their infuſion, careleſly, with the water to be examined; for thoſe who are curious to make good ink, will be eaſily perſuaded, that the deepneſs of the colour, greatly depends upon the proportion of galls to the other ingredient; and, accordingly, that by putting a much greater, or a much leſs quantity of galls, into a certain quantity of a mineral water, the colour reſulting may be more or leſs intenſe. To obviate this inconvenience, I make my infuſion with a certain weight of the powder, in a determinate weight of water; for inſtance, I put about five grains of powder'd galls, to ſteep for five hours, in an ounce of water; but if I uſe the dry powder, I put three or four grains into an ounce of the liquor to be examined; which is a way far more certain than the common, where the ingredients are eſtimated by gueſs. Different proportions of powder'd galls are applicable to the ſame quantity of liquor; for I have obſerved, that there is a great inequality among the mineral waters, in which it may be employed. I have found by trial, that in an ounce of the *German Spaw* water, a ſingle grain of that powder wou'd immediately produce a deep purple colour.

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'Tis an inconvenience, that not only galls, but other drugs, impart a high tincture of their own, to the common water wherein they are infuſed; and, therefore, it were to be wiſh'd, we had ſome drug, that, without communicating a colour to the common water it impregnates, wou'd afford an infuſion fit to ſtrike a blackiſh, or a purple colour, with ferruginous waters.

Tho' it be uſeful, 'tis not always neceſſary, to employ galls, to ſtrike a colour in mineral waters; for the ſame thing may ſometimes be done, tho' more faintly, with oak-leaves; and we may ſucceſsfully ſubſtitute for the ſame purpoſe, ſome other aſtringent vegetables, as dry'd red-roſe leaves, the peel and juice of pomegranates; and that notable ſtyptic, the bloſſoms of the ſame plant, vulgarly called balauſtians; to which may be added, myrobalans, log-wood, *&c.* the ſtrong infuſions whereof I have found to give a tincture very dark and blackiſh, with ſome ferruginous liquors.

Since the galls, *&c.* to be infuſed in common water, are not always of the ſame goodneſs or ſtrength, 'tis adviſeable, not ſo to truſt to any determinate proportion thereof to the water, without the aſſiſtance of the eye, to judge by the colour of the tincture, whether the liquor be duly impregnated.

'Tis hinted, that animal liquors may be employed to produce new colours with mineral waters; becauſe 'tis uſually obſerved in the ferruginous kind, ſuch as thoſe of *Tunbridge*, the *Spaw*, &c. that the groſs excrements of the lower belly, are blacken'd by a mixture of their metalline parts; and in *Tunbridge* waters, particularly, I have obſerved, that after the drinking of large doſes of them, the root of the tongue, and, perhaps, ſome neighbouring parts, wou'd alſo acquire a dark colour.

Tho' the way of trying mineral waters, by the change of colours produced in them by galls, be uſeful, and recommended by being eaſy, cheap, and expeditious; yet I do not take it to be either of that extent or certainty as is vulgarly preſumed. For, perhaps, its only conſiderable uſe is, to diſcover by ſtriking or not ſtriking a blackiſh or purpliſh colour with a mineral water, to manifeſt it to be, or not to be, either of a vitriolic, or a ferruginous nature. But there are many metalline ores, and other mineral bodies, which, not participating of iron, will remain undiſcoverable by this means, and yet ſtrongly impregnate the water. Thus, for example, to try, whether, if arſenic were mingled with water, galls would diſcover it, by producing a dark colour therewith; I put ſome of the powder of them into a decoction

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of arſenic, but did not perceive it gave the liquor any deeper colour, than it would have done to common water. And as this method is but of ſmall extent, ſo neither do I find the informations it gives us, to be ſo certain as they are preſum'd. For, I long ſince found, upon trial purpoſely made, that another body of a metalline nature, which partook not of iron, wou'd, with the infuſion of galls, afford a very dark colour, that might eaſily paſs for the colour produced by a ferruginous water. And I ſuſpect, that all liquors impregnated with iron, are not diſcoverable by the colour they afford with galls; for I have ſometimes made ſuch a liquor, with no other mineral ſubſtance in it beſides ſteel or iron; but I did not find it wou'd turn the infuſion of galls either blackiſh or purple: which led me to imagine, that theſe colours are afforded only by ſuch ferruginous waters, as have been wrought upon, more or leſs, by ſome acid ſalts or fumes.

I might add, 'tis a miſtake that the infuſion of galls will certainly diſcover a mineral water to be vitriolic, by becoming black or purple therewith. This holds true, indeed, if in the vitriolated water, iron be the predominant mineral, or conſiderably participated by the liquor; but if the diſſolved vitriol be altogether copperiſh, I have found, by ſeveral trials, purpoſely made with a ſtrong ſolution of *Roman* vitriol, that it wou'd not, with the infuſion, or tincture of galls, afford either a black, or a blackiſh, but only a thick and muddy colour.

I remember, that from the northern part of *England*, where there are ſeveral mineral waters, a virtuoſo ſent me a large quantity of very whitiſh earth, which he ſuſpected to be of a peculiar nature. Upon examination, it appeared to contain a conſiderable proportion of lead-ore, corroded by ſome mineral ſalts, and incorporated with the ſoil; ſo that if ſearch had been made for mineral waters, in the place from whence this earth came, 'tis probable, that ſome peculiarity being found in the taſt of the water which paſs'd thro' the ſame, it wou'd have been taken for a mineral water, tho' it wou'd have been hard to determine what mineral it partook of; and, perhaps, by endeavouring to ſolve the doubt, by drinking it, very bad effects might have thence enſued. But, probably, the ſulphureous ſpirit we ſhall preſently deſcribe, wou'd have ſhewn that water to be impregnated with a body of the nature of vitriol, but not the common ſort. For tho' galls give no very blackiſh colour to a ſolution of *Saccharum Saturni*, that is, the vitriol of lead, in diſtill'd or rain-water; yet I found this volatile ſulphur wou'd ſoon manifeſtly do it: which expedient I made uſe of, becauſe I had not then at hand the ores of lead, copper, &c. For the ſame reaſon I contented my ſelf with the ſolutions of the ſeveral metals in their proper menſtrua; for 'tis probable, that the metalline parts of the ores, wou'd have afforded either the ſame, or ſimilar ſolutions, in the ſame menſtrua; which conſiſting of nitre, ſea-ſalt, and vitriol, bodies that abound in ſeveral parts of the earth thro' which ſprings flow, their ſeveral impregnated waters might exhibit phenomena of the ſame kind. We made then, among others, a ſolution of fine gold in *Aqua regis*; another of common running mercury in *Aqua fortis*; and a clear one of tin, in a peculiar ſolvent that readily acts upon it, and keeps it permanently diſſolv'd. To theſe ſolutions I put galls, without obtaining any blackiſh colour, except from that which contained gold; but with our ſulphureous liquor, we obtained notable changes of colour, tho' 'twas dark in all of them except one, or tending to blackneſs. And tho' for that reaſon a careleſs eye might judge them indifferently blackiſh, yet, ſince the degrees, or ſome other modification of the ſame dark colour, ſeemed plainly not to be the ſame in them all; 'tis poſſible, that a very careful view may diſcern ſome little differences between thoſe obſcure colours, from whence to form a conjecture, what metalline ſubſtance is contained, or at leaſt predominates in the reſpective liquors. And I particularly remember, that the colour which aroſe from our ſulphureous liquor, and the ſolution of tin, was manifeſtly diſtinguiſhable from thoſe produced in any of the other ſolutions; being not black, or blackiſh, nor ſo much as purple; but of a kind of browniſh yellow.

The common method of examining mineral waters improved.

I do not, however, ſlight the uſe of galls, *&c.* even as they are vulgarly employ'd; but am apt to think, that the way of examining mineral waters, by the changes of their colour, when they are mixed with proper materials, may be render'd very extenſive and uſeful: to which purpoſe I wou'd recommend the following particulars. (1.) It ſeems neceſſary, that the change of colour be regarded, both while 'tis producing, and when produced, in a good light, and with a careful eye; for, by this means may be diſcovered ſeveral ſhades, or varieties, of the more principal colours, and ſome other circumſtances, that cou'd not otherwiſe be taken notice of; which yet may afford good hints to a ſagacious obſerver. (2.) The circumſpection here recommended, may, perhaps, be more inſtructive, by a way I have ſometimes practiſed, to vary the ſhades, and other phenomena of colours, produced with mineral liquors. This conſiſts chiefly in preparing ſheets of white paper, by drenching them in ſtrong infuſions of brazil, log-wood, or other convenient dying ſtuff, and then letting them dry leiſurely in the air. Upon ſeveral parts of this paper, ſome drops of the mineral liquor being let fall, and then ſuffered to ſpread, and change their colour; a curious obſerver may, from hence, be aſſiſted to gueſs, what kind of mineral impregnates the liquor, and in what quantity; eſpecially if the liquor be of a ſaline nature, and on the ſame ſheet, ſome other convenient mineral water, or other fluid, be likewiſe dropt; that the changes of colour produced by the two, may be ſurveyed and compared together. I, alſo, practiſed another way, ſomewhat different from this, by rubbing ſome proper powders, as that of *Engliſh* vitriol, (lightly calcined, in a gentle heat, till it becomes of a greyiſh colour, and friable between the fingers,) with a hair's foot upon white paper, till the finer parts thereof having lodged themſelves in its pores, with-

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without greatly diſcolouring it; when the ſuperfluous duſt was ſtruck off, it became capable of affording a variety of colours, or rather ſhades, ſome deeper, and others fainter; and then I let drops of different ferruginous liquors fall thereon. Several variations of colour may, likewiſe, be produced by infuſing, or otherwiſe mixing a material with the mineral water, before the tinging one be joined with it; by putting ſomewhat into the infuſion or powder of galls, before it be added to the water; or, laſtly, by dropping proper liquors, ſuch as ſpirit of ſalt firſt, then ſpirit of urine, or oil of tartar, into the mixture of galls, and the ſubject to be examin'd. (3.) It is not proper to confine one's ſelf to the uſe either of galls or oak-leaves; red roſes, balauſtians, log-wood, brazil, and other aſtringent vegetable pigments, may be alſo employ'd. For tho' ſome of theſe give a deeper tincture than galls, yet, by the diverſity of colour they produce in mineral waters, an attentive ſpectator may diſcover ſome things that he would not be informed, or receive any hint of, by the help of galls or oak-leaves alone. Nor would I have only vegetable ſubſtances employ'd about ſuch colourations, but ſometimes animal, and often mineral ones; for by this means, experiments will be diverſified, and the number of phenomena encreaſed; ſome of which may, probably, prove inſtructive. I know ſeveral other ſubſtances that will, as well as galls, turn black in vitriolic waters, whether of the iron or copper kind. And for a liquor that will preſently turn black with either: take equal parts of pure ſalt of tartar, flowers of ſulphur, and good ſal-armoniac, reduce the firſt and the laſt to powder ſeparately, melt the ſulphur, over a gentle fire, and, by degrees, put to it the ſalt of tartar; ſtirring them well, that they may incorporate and grow reddiſh; then put the mixture, pulverized, into a glaſs-retort, pour on it the ſal-armoniac diſſolv'd in fair water; and cloſing well the junctures, diſtil all in ſand, by degrees of a moderate fire; ſhifting the receiver once or twice, becauſe the liquors will be differently ting'd and ſtrong, and that which aſcends laſt, may bring over but very little of the ſulphur, whoſe volatile tincture is yet the chief thing we aim at in this operation. (4.) I queſtion not, that he who makes a ſkilful uſe of the ſeveral drugs, and other bodies, vegetable, animal, and mineral, which may produce new colours with mineral waters, or the ſubſtances that impregnate them, will thereby diſcover the preſence or abſence of many other minerals therein, ſome of them ſalubrious or ſafe, and others hurtful or dangerous, that remain unobſerv'd by thoſe who content themſelves to employ only galls and oak-leaves in the examination of them. For ſome of theſe liquors contain ſalts that, having corroded either iron or copper ores, or marcaſites, do not betray themſelves, by producing either an inky, a fainter degree of blackneſs, or a purple, with the drugs commonly made uſe of to change their colours. And of theſe ſalts I have met with more than one ſort. (5.) I think it, likewiſe, very poſſible, that induſtrious men may find means to diſcover, by the help of this change of colours, whether orpiment, native arſenic, or the like poiſonous minerals, impregnate a water, ſo as to make it very hurtful or dangerous. But as for ſulphur, ſeveral waters may partake thereof without being perceived to do ſo. I have, ſometimes, purpoſely made a liquor, limpid like ſpring-water, that would totally evaporate by a gentle heat; and yet this liquor was highly impregnated with a mineral ſulphur, as I convinc'd ſeveral virtuoſi by manifeſt and ocular proofs. So that if ſulphur chance to be combined with any of thoſe many hidden ſubterraneal ſalts and minerals, that can ſuppreſs or diſguize its peculiar odour, a water may be conſiderably, tho' unobſervedly impregnated with it: yet this is, probably, diſcoverable by the change of colour, producible in ſuch a ſulphureous liquor by vitriolic bodies, and other proper materials; for tho' the ſpirit lately deſcrib'd be very tranſparent, and totally volatile in the form of a liquor, ſometimes pale; yet common *Engliſh* vitriol, as alſo that of *Dantzick*, which is of the copper kind, will preſently turn it of a black or very dark colour. And, what ſeems more difficult, I have deviſed a method whereby it appears, that even ſolid copper may be ſo ſubtiliz'd and diſguiz'd, as to ſend out a multitude of its metalline parts, with others, in the form of a tranſparent liquor, like common water; when by putting to it a little of another ſubſtance, as volatile and colourleſs as it ſelf, it would preſently diſcloſe the metal it contained, by turning blue as a ſapphire. (6.) Becauſe arſenic is a pernicious drug, and yet has been ſuſpected to be clandeſtinely mixed with mineral waters; which ſeems the leſs improbable, becauſe ſome of the marcaſitical bodies, waſh'd by particular mineral waters, are thought to contain it; and becauſe galls fail'd to diſcover this poiſonous drug in water, that was copiouſly impregnated with it, I made ſome trials, to diſcover, at once, its exiſtence in water, and the nature of ſo dangerous a mineral.

To diſcover whether a mineral water be arſenical.

Happening, ſome years ago, to taſt arſenic, not without a little danger and inconvenience, its poiſonous nature did not from thence ſeem to me to conſiſt in a highly acid ſalt, but to be of an exceeding corroſive or fretting nature, peculiar to it ſelf. Of this mineral I made a ſtrong ſolution in common water, wherein ſome skill is required to diſſolve it, and mix'd a ſmall proportion thereof with ſome *German-Spaw* water; then dropping into this mixture a little highly dephlegmed ſpirit of urine, we perceiv'd a light lacteſcence to be produced, and a whitiſh precipitate very ſlowly to ſubſide therein.

We found, alſo, that a little oil of tartar *per deliquium*, being drop'd into ſome of the ſolution of arſenic, produced a heavy, whitiſh cloud, which preſently ſettled on the lower part of the glaſs: we, likewiſe, put oil of vitriol into the ſaid ſolution, but did not perceive that the oil cauſed a precipitation, or wrought much otherwiſe on it than it would have done upon common water.

From which experiments it may be ſuſpected, that arſenic is chiefly an acid body.

But by mixing ſome of this arſenical liquor with ſyrup of violets, we found it ſlowly change the ſyrup, rather to a green, than a red or purple colour: and to another portion of the ſame liquor we put ſome of our volatile ſulphureous ſpirit, but no precipitation enſued.

For a ſeverer ſcrutiny, we uſed a method, that is very ſucceſsful in diſcovering ſuch ſlight degrees of acidity as are not diſcoverable by ordinary tryals; but we cou'd not, by this way, diſcern the leaſt acidity in our arſenical ſolution, but rather a manifeſt ſign of an urinous or lixiviate quality. And by putting ſome of the arſenical liquor into a ſtrong ſolution of common ſublimate, made in fair water, we had a copious precipitate, ſuch as might have been expected from an alkaline precipitant. And this was not brick-coloured, like what fix'd alkalies produce with diſſolv'd ſublimate, but white; ſuch as urinous or volatile alkalies, as they call them, make with the ſame liquor.

Upon the whole, tho' arſenic be a very corroſive body, and, perhaps, upon that ſcore poiſonous; yet its deleterious nature ſeems not to conſiſt in a tranſcendently acid, lixiviate, cauſtic quality; but, as we before conjectured, in a peculiar kind of corroſiveneſs.

I ſhall add, that upon caſting about in my thoughts for an uſeful method to examine mineral waters, ſuſpected to contain arſenic; I, at length, made choice of vitriolate bodies for that purpoſe; and found, that if a ſolution of *Dantzick* vitriol were put to a convenient quantity of arſenical liquor, there would preſently enſue a great change of colour; and a dark ſubſtance, by degrees, precipitate it ſelf, and ſettle in the lower part of the glaſs. The like effect we found when we put *Engliſh* vitriol, (which having no copper added in its preparation, as that of *Dantzick* has, is either wholly, or almoſt ferruginous,) into a conſiderable proportion of the arſenical ſolution.

14. *If any thing will be precipitated out of the mineral waters by ſalts or ſaline liquors; whether they be acid, as ſpirit of ſalt, or of nitre,* Aqua fortis, *&c. volatile alkalies, as ſtrong ſpirit of urine, ſal-armoniac,* &c. *or lixiviate ſalts, as oil of tartar* per deliquium, *fixed nitre,* &c.

15. *To examine, by evaporation, whether the mineral water contains common ſalt, and if ſo, whether in a great or ſmall quantity.*

Common ſalt contained in mineral waters.

Becauſe it often happens, that men have not the leiſure and conveniency totally to evaporate a mineral water, it may be uſeful, without evaporation, to diſcover, whether it contains any common ſalt; and if ſo, to make ſome eſtimate how copiouſly or ſparingly the liquor is impregnated therewith. This I might eaſily ſhew how to perform exactly, if I were not juſtly reſtrained, for a while, from communicating that way of examining the ſaltneſs and freſhneſs of waters, whereof, by the king's command, I exhibited to his majeſty ſome proofs, ſoon after mentioned in the *Gazette*; however, ſome gueſs may be made at the ſaltneſs of waters by obſerving whether they will lather with waſh-balls, or ſoap; and if they will not, what quantity of curdled matter they produce; as, alſo, whether they will ſerve for the waſhing of linen, and the boiling of peas tender; which two are the moſt uſual ways that ſeamen take, to examine the goodneſs of unknown water. In ſeveral purging waters, it may be difficult to practiſe this method with certainty, becauſe other ſalts may happen to predominate in them; but in the examination of lightly ferruginous ſprings, it is more to be relied upon. 'Tis remarkable, that when I uſed my own way of examining the ſaltneſs of mineral waters, I found even the lighteſt ſort of them contained common ſalt, but in different proportions; thus not only in the ſeveral waters of *Iſlington*, *Hampſtead*, and ſome others, afforded it, but particularly thoſe of the *German-Spaw*, and *Tunbridge*, did the ſame. And, indeed, I have long known, that more or leſs common ſalt is very uſually harboured, unobſerved, in many ſoils, thro' which all ſorts of ſprings have their courſe.

16. *To examine, without evaporation, whether the mineral water have any acidity, tho' ever ſo little.*

Acidity no common quality in them.

Tho' acidity be ſo frequently a manifeſt quality of mineral waters, as to cauſe them to be divided into *Acidulæ* and *Thermæ*, yet I have found, by ſeveral trials, that 'tis not near ſo eaſy as men preſume, to diſcover a manifeſt acidity in all thoſe that are not ſulphureous or hot. For, ſeveral ferruginous waters having, probably, ſpent what acidity they had, upon the iron-ore which they diſſolved in their paſſage, retain but little of that property, which they manifeſt ſo faintly, by working upon coral, by any conflict with ſpirit of urine, &c. or by changing the colour of ſyrup of violets, that I ſhou'd ſometimes have concluded, they had no acidity at all, were I not provided of a way to diſcover a far leſs degree of it, than the vulgar trials take notice of; which is by their operation upon the colours of an infuſion of *Lignum nephriticum*, made in limpid water. By this means, I found the *German Spaw* water to retain a little acidity, even here at *London*; but ſeveral of our own ferruginous ſprings did not, even upon this trial, appear to have any. Nor did I find even ſome of the purging ſprings, particularly that of *Acton*, to have any diſcernable acidity.

17. *The liquor, or liquors, it affords by diſtillation* in balneo, *and other treatment.*

18. *The ſediment, or* Caput mortuum, *of the mineral water, when the liquor is totaly evaporated, or diſtilled off; and whether the remainder be the ſame in quantity and quality, when ſeverally produced by thoſe two ways.*

19. *Whether the water, being ſlowly and warily abſtracted to a thickiſh ſubſtance, in glaſs veſſels exactly luted, and again mixed with the diſtilled fluid, wou'd re-compoſe a mineral water, of the ſame texture and qualities it had at firſt.*

20. *Whether a glaſs full of it, being hermetically ſealed up, and boiled in common water, deep enough to keep it always cover'd, will have its texture to alter'd,*

alter'd, as to ſuffer an obſervable change in any of its manifeſt qualities; and if it do, in what qualities, and to what degree of alteration.

There is a double deſign in this enquiry. Firſt, to diſcover whether a change of texture wou'd remarkably alter the qualities of the liquor, when the hermetical ſeal hinder'd the avolation of any ſaline, ferruginous, or ſpirituous parts: and, ſecondly, to ſee whether ſuch an agitation by heat, as in the open air prevents the *Spaw* water from making a purple colour with galls, wou'd cauſe any manifeſt ſeparation of parts in the liquor, and cauſe any groſſer ſubſtance to precipitate, or ſubſide. We twice attempted the experiment with *Spaw* water, but without ſucceſs; for the firſt time, the glaſs broke at the bottom, before the water, wherein we immers'd it, was near boiling hot; and tho' the other glaſs reſiſted longer, and endured a greater heat, yet in a few minutes that alſo broke at the bottom: which diſappointments a faithful hiſtorian ought not to conceal.

21. *What proportion the dry* Caput mortuum *bears to the mineral water that affords it.*

22. *The diviſion of the* Caput mortuum *into ſaline, terreſtrial, and other parts not diſſoluble in water, in caſe it contain both, or more ſorts.*

23. *The proportion of the ſaline part of the* Caput mortuum, *to the terreſtrial.*

24. *The fixity, or volatility, of the ſaline part in ſtrong fires.*

25. *Whether the ſaline part will ſhoot into cryſtals or no; and if it will, what figure the grains are of; but if it will not, whether, being combined with a ſalt of that property, as purified ſea-ſalt, for inſtance, it will then cryſtallize; and if it do, into what figures it ſhoots, and, particularly, if they are reducible to thoſe of any ſpecies of known ſalts.*

26. *To examine whether the ſaline part be predominantly acid, alkaline, or adiaphorous.*

To find what ſalts predominate in particular mineral waters.

Various ways may be propoſed, to diſcover which of the qualities mentioned in this article, is predominant in the ſalt to be examined; but, I confeſs, I doubt whether any of them be certain.

If acidity be the predominant, it will, probably, appear by the taſt, odour, or both; by working upon powder'd coral, or crabs eyes, curdling milk, turning ſyrup of violets reddiſh, deſtroying the blue colour of the infuſion of *Lignum nephriticum*, by not precipitating with ſtrong acid liquors, as oil of vitriol, ſpirit of ſalt, *&c.* and, laſtly, by precipitating with oil of tartar *per deliquium*, ſtrong ſpirit of urine, *&c.* But I ſtill doubt, whether theſe proofs be abſolutely certain; for, if I miſtake not, I found ſome purging mineral waters, that wou'd not give even ſo ſlight a proof of acidity, as to deſtroy the blueneſs of the nephritic tincture, tho' they wou'd curdle milk; and, on the contrary, I found, that ſome *Spaw* water wou'd not curdle milk, and yet readily deprive the ſaid tincture of its colour: which ſome of our *Engliſh* ferruginous waters were, at leaſt when brought to *London*, unable to do.

The predominancy of an alkali in the ſalt of a mineral water, may be, probably, diſcovered by the lixiviate taſt and ſmell; the former of which may be obſerved in the true nitre of the ancients; by turning the ſyrup of violets green; by precipitating a ſolution of ſublimate, made with ſpring-water; by an effervеſcence, or conflict with ſome potent acid, as *Aqua fortis*, or well dephlegmed ſpirit of ſalt; by heightning the red tincture of log-wood, or brazil, drawn with common water; to which may be added, a nicer way or two, that I have elſewhere mentioned. But I propoſe theſe methods of examination, only as they appear rational; becauſe I have ſucceſsfully tried them with other ſaline bodies, that were alkalizate: for, as to thoſe mineral waters I have examined, an alkali appeared to be predominant in none of them.

But further enquiry may diſcover to others here in *England*, what I have not yet met with: doubtleſs there are in many parts of the earth, ſalts of an alkaline nature. And, I preſume, the *Egyptians* might find, among their ſprings or wells, ſeveral waters impregnated with them; for I found by trials, purpoſely made, upon the true *Egyptian* nitre, that the native ſalt exhibited ſeveral of the ſame phenomena, with other factitious alkalies: and ſome ſalt afforded by the famous waters of *Bourbon* in *France*, being brought me to examine, I found it to be evidently alkaline; for it wou'd make a conflict with acids, and preſently turn ſyrup of violets green.

If we ſuſpect vitriol to predominate in the ſaline part of a mineral water, we may endeavour to diſcover it, by its blackning a ſolution of galls; by its vomitive operation upon the drinkers; (tho' this may ſometimes prove uncertain; eſpecially becauſe an inviſible mixture of arſenic, or, perhaps, arſenical fumes, may give the water an emetic quality;) by putting alkalies to a ſtrong ſolution of the ſuppoſed vitriol, and obſerving whether it will afford a yellow, or yellowiſh precipitate, if ſalt of tartar, or ſpirit of urine, be dropt into it; and, laſtly, by taking notice, whether a ſulphureous ſpirit will make a blackiſh, or a very dark colour with it; as I found it would do with ſeveral vitriolic liquors; and even in one, wherein we had diſſolved but a grain of a natural vitriolic ſubſtance, in above four or five thouſand times its weight of ſyrup or water. But I do not remember to have found vitriol a manifeſt ingredient in any of the waters about *London*: which ſeems the more remarkable, becauſe ſeveral places about that city abound with marcaſites, the parents of vitriol. And a curious *French* gentleman, who had a particular occaſion to take notice of the ſediments of many mineral waters in his own country, told me, he never met with any that was manifeſtly vitriolic: and he ſeem'd to be of opinion, that no vitriolic ſpring had yet been diſcover'd, among the many mineral ones of *France*.

Since we ſo rarely meet with either manifeſtly acid, or evidently alkaline ſalts, in our *Engliſh* mineral waters; it may deſerve a ſerious enquiry, what other ſalts they may be impregnated with; and eſpecially from what ſalts, the purgative virtue that is found in many of them, as thoſe of *Epſom*, *Barnet*, *Acton*, &c. proceeds. Common ſalt, indeed, as is already noted, I have found tokens of in the *German Spaw* water, and in all the *Engliſh* mineral waters, without exception, that I had occaſion to try; yet I did not find that ſalt ſo plentifully in any of them, as to diſcloſe it ſelf by cryſtallizing into cubical grains. And the way I made uſe of to examine the ſaltneſs of the water, without cryſtallization, is not equally certain in all ſorts of them. But becauſe I had not enough of theſe liquors to evaporate them in large quantities, tho' I could not diſcern in the clear ſalts they afforded, either vitriol, ſalt-petre, alum, or even common ſalt, by their peculiar and genuine figures; I dare not confidently ſay, that none of our *Engliſh* ſprings abound with any of thoſe ſalts. However, as far as I can gueſs by the trials I have hitherto made, the ſalt that is found in our purgative waters, and plentifully in ſome of them, does not belong to any known ſort of ſalts; but is either of a kind for which we have yet no name; or, what ſeems more probable, is a ſalt of a compound nature, made up by the coalitions of ſome, or all of the ſalts abovementioned, with, perhaps, ſome other ſubterraneal, nameleſs ſalt, which the ſpring diſſolves in its paſſage. That two bodies, neither of them cathartic, may, by a change of texture in each, compoſe a third body that is briskly purgative, I have found by experience. Beſides, by burning ſalt of tartar with about double its weight of common ſulphur, I thence obtained, as I expected, a neutral ſalt, that had peculiar qualities, different from thoſe of the bodies employed to compoſe it: and an ingenious empiric told me, that in the doſe of half a dram, being taken in wine, or broth, it wou'd purge conſiderably, yet gently, and without griping. And I have ſometimes made out of common ſulphur, a cryſtalline ſalt of a vitriolic taſt; the like to which may, poſſibly, be made under-ground, where there are ſubterraneal fires, tho', perhaps, not obſerved, nor ſuſpected; ſince we prepared this ſalt, without adding any thing to the ſulphur, only by the help of fire and common water. And I remember, that a great virtuoſo, ſeveral years ago, brought me a certain unknown ſalt, afforded by a ſpring adjoining to his eſtate in the weſt of *England*, which I quickly told him was of the nature of the *Sal mirabile Glauberi*, and predicted the phenomena it would exhibit upon particular trials; which came to paſs accordingly.

27. *The obſervables in the terreſtrial portion of the* Caput mortuum, *in reference to the ſaline; its colour, odour, volatility, or fixity in a ſtrong fire; its ſolubility or inſolubility in ſeveral menſtrua, as ſpirit of vinegar, ſpirit of wine, oil of tartar*, &c.

Different quantities of Caput mortuum *afforded by different mineral waters.*

'Tis ſurprizing to obſerve, how great an inequality there ſometimes is, in the proportion that the ſame quantity of two different mineral waters bears, to the *Caput mortuum* they reſpectively afford: ſince a pound, for inſtance, of one, may, after evaporation, leave behind it, perhaps, more drams of a dry ſubſtance, than a pound of the other leaves grains.

As far as I have hitherto obſerved, thoſe ferruginous waters that are not heavier than common water, and uſually prove diuretic, afford but little *Caput mortuum*, or dry ſubſtance, upon the total evaporation of the liquor; whilſt mineral waters that are purging, and manifeſtly more ponderous, *in ſpecie*, than common water, leave, after exhalation, a conſiderable quantity of reſidence, tho' ſome far leſs than others.

From a pound of *Barnet* water, which is purgative, ſlowly evaporated, we obtained a dram of white powder; but from the like quantity of *Tunbridge* water, only about one grain of *Caput mortuum:* and, if I miſremember not, we had but about a grain and a half, from twenty-five ounces of *German-Spaw* water.

It may ſeem ſcarce credible to many, that ſo ſmall a quantity of matter, of which, perhaps, not one half is ſaline, or metalline, ſhould impart a manifeſt virtue to ſo great a proportion of water: but this difficulty did not much trouble me, having purpoſely made ſeveral experiments, to diſcover how ſmall a proportion of mineral matter may ſuffice, when diſſolved, to impregnate common water. One grain of iron-ſtone, caſually found near the ſprings at *Iſlington*, (from which mineral, thoſe waters probably derive their virtue,) being opened by fire, and diſſolved, as far as it wou'd, in a little ſpirit of ſalt, we let fall a drop or two of the yellowiſh ſolution into a great proportion of the infuſion of galls, to which it preſently gave a deeper colour than *Tunbridge* water, or even that of the *German-Spaw*, uſually affords, here at *London*, with the powder of galls: ſo that we imagined, if we had then at hand a competent quantity of the infuſion, the remaining part of the ferruginous ſolution wou'd have colour'd a ten times larger quantity of the infuſion, than our trial was made upon. This will be eaſily credited by him, who conſiders an experiment we, afterwards, made to the ſame purpoſe, by diſſolving half a grain of a good marcaſite, taken up not far from *London*, in a ſmall quantity of ſpirit of nitre. This ſolution we put into a pound of a pretty high tincture of galls, made by infuſing them in common water; and finding, as we expected, that the mixture grew very dark, we filled a vial with it, and emptying that vial into a larger glaſs, we filled the ſame vial three times with common water to dilute it; notwithſtanding which, this new mixture, being put into one of our uſual glaſſes, appeared of a colour much deeper than that which the water of *Tunbridge*, or the *Spaw*, had formerly given with the powder of galls: ſo that, probably, if another vial of common water had been added, it wou'd yet have afforded a purple colour, if not a deeper: ſo that one part of a diſſolved marcaſite communicated a tincture to 61440 parts of the infuſion of galls. And what makes the experiment more conſiderable, is, that this ſmall quantity of marcaſite, was not it ſelf wholly ferruginous, or metalline: for, from our *Engliſh* marcaſites, as well as others, I have obtained a conſiderable quantity of ſulphur like the common ſort; beſides which, they afford a conſiderable one of a terreſtrial ſubſtance.

Since, then, the marcaſite impregnated ſo much water with its groſs parts, obtain'd by a bare ſolution, it ſeems highly probable, that the ſame quantity of liquor may be impregnated by a far leſs quantity of mineral matter, attenuated by being rais'd in the form of fumes or exhalations: and, that imperfect or embryonated iron may be thus raiſed, appears from hence, that iron will manifeſtly emit copious fumes, without the help of external fire. And if it be with ſome ſuch ſpirituous and volatile exhalations, that a mineral water, as thoſe of *Tunbridge* and *Iſlington* is impregnated, 'tis eaſie to conceive how they may ſoon loſe their chief virtues by the avolation of their fine parts, upon their being removed to a diſtance from the ſpring-head. And to make it probable, that vitriolate corpuſcles may be made to aſcend without loſing their nature, I ſhall here mention an experiment that I deviſed, to give ſome light into this matter. I had often found, by tryal, that a ſpirit, richly impregnated with volatiliz'd ſulphur, wou'd, with vitriol, whether in the form of a powder, or a ſolution, produce, in a trice, a very dark or blackiſh colour: and gueſſing, that in mercury, turn'd, by the addition of ſalt and vitriol, into corroſive ſublimate, many of the vitriolate corpuſcles might aſcend with the mercurial ones, I drop'd a volatile ſulphureous tincture upon good ſublimate, and found it preſently turn to a very opake colour. To ſhew, alſo, that to make a great dilatation or diſperſion of the ferruginous corpuſcles of an ore or mineral, there needs no ſpirit of ſalt, or the like diſtill'd menſtruum; I procured, from a place where artificial vitriol is made, ſome of the liquor they employ before they caſt in iron, that being corroded thereby, it may increaſe the weight, and give ſolidity and ſome other qualities to the deſign'd vitriol. For tho' this liquor be made without any chymical menſtruum, barely by rain or ſnow-water, that impregnates it ſelf with ſaline or metalline particles, in its paſſage thro' beds of marcaſites, that lie expoſed to the ſun and air; yet in this water ſuch numbers of ferruginous corpuſcles are diſpers'd, that having let fall four drops of it into twelve ounces and a half of common water, this liquor, as I expected, was thereby ſo much impregnated, that, with powder of galls, it preſently produc'd as deep a colour as good *Tunbridge* water would have done. So that ſuppoſing a drop of this liquor to weigh about a grain, as by ſome tryals purpoſely made we found it did, we ſee that one part of the vitriolate water was able, manifeſtly, to impregnate fifteen hundred parts of common water. And yet, of theſe four drops or grains of the vitriolate liquor, a conſiderable part may very probably be concluded, from the way of its production, to have been rain-water; ſince, to examine this ſuppoſition, we ſlowly evaporated ſome ounces of that liquor, and found the remaining dry ſubſtance amounted not to the fourth part of the weight of the whole; whence 'twas eaſie to conclude, that one grain of vitriolate ſubſtance wou'd have impregnated ſix thouſand times its weight of common water, ſo as to make it fit to produce, with galls, a purple tincture. We afterwards found, upon a careful tryal, that the experiment will hold, tho' the proportion of the water, to the grain of tinging ſubſtance, ſhou'd exceed that above-mentioned by the weight of ſome hundreds of grains.

28. *Whether, and how much, the earth of the mineral water loſes by a ſtrong and laſting ignition; what changes of colour,* &c. *it thence receives; whether it be, of it ſelf, capable of vitrification; and what colour it will impart to fine pulveriz'd* Venice *glaſs, when exactly mix'd therewith, and flux'd into a tranſparent glaſs.*

29. *The œconomical and mechanical uſes of the mineral water in brewing, baking, waſhing of linen, tanning, dying,* &c. *as theſe may, ſeverally, aſſiſt in diſcovering the ingredients and qualities of the liquor.*

30. *How to imitate the natural medicinal waters, by chymical and other artificial means, in order to diſcover the quality and quantity of the ingredients that impregnate the ſame.*

Artificial Spaw-water.

To make a ſuccedaneum for mineral waters, ſuch as thoſe of the *Spaw* or *Tunbridge*, we took one part of very good filings of iron, and ten parts of good diſtill'd vinegar. Theſe were put into a bolt-head well ſtopt; and then, in a mild heat of ſand, we digeſted them for about two days, and afterwards augmented the heat till the liquor appear'd of a deep orange colour, yet tranſparent. Part of this tincture we poured off, and kept well ſtop'd by it ſelf; becauſe, tho' by a longer digeſtion and a greater heat, we obtain'd a very red tincture, yet we did not ſo much value it, becauſe, when the menſtruum is too much impregnated, the metal uſually precipitates, and the fine colour is deſtroyed. Of the firſt tincture we let fall four drops into eight ounces and an half of clear common water, whoſe colour was not thereby ſenſibly alter'd; and the vial, containing this mixture, being well ſhaken, that the tincture might diffuſe it ſelf the more thorowly, we kept it carefully ſtop'd for uſe, as being our factitious *Spaw* water. A ſpoonful or ſomewhat more of this, with about a quarter of a grain, or leſs, of good freſh powder of galls, would preſently afford a purpliſh tincture, like that of natural ſprings impregnated with iron; and if the mouth were waſh'd therewith, it appear'd to have, like thoſe natural waters, a manifeſt ferruginous taſt. But theſe artificial [illegible] ought to be adminiſter'd ſoon after they are made; for experience has inform'd me, that when kept too long, they loſe much of their briskneſs and force. I ſometimes here perceived, there would ſubſide to the bottom, a certain reddiſh ſubſtance, as it were oker; which ſhew'd the degeneracy of the liquor: and ſome ſuch thing I have obſerv'd in natural chalybeate waters, too long or negligently kept.

31. *Particulars omitted, but directly belonging to the hiſtory of mineral waters.*

32. *Miſcellaneous obſervations and experiments, indirectly referable either to one or more of the ſpecified heads, or to the common ſubject of them all.*

SECT. IV.

Heads for the natural hiſtory of a mineral water conſidered as a medicine.

WE come, in the laſt place, to give a ſet of heads for the hiſtory of a mineral water, conſider'd as a medicine.

1. *To what tempers and conſtitutions the propos'd mineral water is the moſt proper, to what leſs proper, and to what noxious or inconvenient.*

2. *In what ſtated diſeaſes and particular caſes it is proper, or ſuſpected to be dangerous, if not certainly hurtful.*

3. *What difference there is between the water taken up, and preſently drunk at the ſpring it ſelf, or other receptacle, and when carried to ſome diſtance from thence, whether in open or well clos'd veſſels.*

4. *The manifeſt operations of the water in thoſe who take it, whether by vomit, ſtool, urine, or by any two, or all of theſe ways together.*

5. *Whether any occult virtues are diſcoverable in the mineral water, and if any, what they are.*

6. *What difference in the effects of the mineral water proceeds from its being drunk, all of it, quite cold, or hot, or luke-warm, or one part when 'tis in one of theſe tempers, the reſt when in another.*

7. *How to promote or facilitate the operation of the water in ſome, by taking it in bed, and in others, by moderate exerciſe.*

8. *What aſſiſtance may be afforded to the operation of the water, by giving with it, eſpecially in the firſt draught, ſomething to make it paſs the better, to correct its crudity, or ſtrengthen the ſtomach and* viſcera.

9. *What advantages may accrue from preparing the patient's body before he enters upon his courſe of the waters; and what inconveniencies may attend the neglect of ſuch preparation, eſpecially in groſs, foul, or much obſtructed bodies.*

10. *The aſſiſtance the water may receive by gentle purging medicines, diſcreetly given at proper intervals.*

11. *The moſt proper doſe or quantity of the water to be taken at once; the compaſs of time wherein it ſhou'd be all drunk; and the gradual encreaſing and leſſening the doſe required at the beginning, and ſometimes before the end of the whole time appointed for taking it.*

12. *How much the greater or leſſer ſpace of time, ſpent in taking the water, conduces to its good effects; and what is the fitteſt meaſure of time to continue the drinking of it; reſpect being had to the patient's ſtrength, diſeaſe, the time of the year, the accidental temperature of the air, and other conſiderable circumſtances.*

13. *Whether the drinking of the mineral water, for ſeveral years together, be found neceſſary, or more beneficial, than to intermit it ſometimes, for a year or two, or perhaps longer, and then to repeat the uſe of it.*

14. *The regimen, as to meat, drink, exerciſe, ſleep,* &c. *that ought to be obſerved by thoſe who take the water; and of the inconveniencies that are apt to follow a neglect herein.*

15. *The ſigns that ſhew the water to work kindly and effectually; and the ſigns of its doing the contrary; with thoſe of its having proved already hurtful; or of its being likely to prove ſo.*

16. *The inconveniencies, or ill accidents, obſerved to happen, either during the courſe, or ſome time after 'tis over; eſpecially to perſons of particular conſtitutions, or in particular circumſtances; and the means to prevent or remedy ſuch inconveniencies.*

17. *Whether it is neceſſary, or uſeful, to take phyſic, after the courſe is finiſhed; and, if it be, what are the fitteſt times and medicines to be employed, to prevent any bad effects; and what is the danger of neglecting to make uſe of them.*

18. *Whether, and how the mineral water may be uſefully given, by being added to other liquors, or things; as by boiling meat in it, or by receiving, together with the addition, a farther preparation, as when wine,* &c. *is mixed with it; or when with milk 'tis made into poſſet-drink; or, laſtly, when brew'd with malt alone, or with that and hops, and ſo turned into ale or beer.*

19. *Whether any ſuch ſaline, or other ſubſtance, may, by evaporation, inſpiſſation, calcination,* &c. *be extracted from the mineral water, as, being given in a ſmall doſe, may be ſubſtituted as a ſuccedaneum to large quantities of the natural water.*

20. *Of what uſe the mineral water may prove, when outwardly applied, as by waſhing ſore eyes, or ulcers bathing in it,* &c. *and whether the mud, or ſediment, it leaves where it paſſes, or ſtagnates, being externally applied, may have the ſame, or other medicinal virtues; and if ſo, how that is to be adminiſtred to make it exert them.*

21. *Some mechanico-medical trials to be made upon animals, which may help us to conjecture at the qualities of the mineral waters; as by injecting it into the veins of a dog, to try, whether it will coagulate his blood, make it more fluid, or powerfully operate by vomit, ſtool, or urine; as alſo by keeping a dog very long, without allowing him any other liquor than the mineral water.*

But I propoſe ſuch particulars as theſe, only as analogous experimens, or ſuccedanea to trials, that cannot well be made in the human body. And, indeed, all the heads of this third part of our deſigned hiſtory, belong properly to phyſicians; many of whom are far better qualified to cultivate this ſubject, than I: for which reaſon I willingly reſign it into their hands.

Thus much, however, I muſt be allowed to ſay, that to compile an accurate hiſtory of mineral waters, is a taſk of exceeding great difficulty. There are ſo many circumſtances of ſeaſons, weather, place, with a multitude of other contingencies, which may vary the phenomena and effects of theſe waters, that to comprize ſo many different things at once, and ſurvey them at one view, ſo as to be able to pronounce with

MEDICINE. with certainty, upon the nature, the medicinal operations, and other effects thereof, ſeems, till farther trials and enquiries have been made about them, a thing impoſſible.*

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* That the nature and properties of mineral waters may change in time, or by accident, we have a remarkable inſtance in thoſe of *Paſſy* in *France*, which M. *du Clos* firſt examined, with great care; and, in a few years after, M. *Lemery* coming to examine them again, found them quite different. See *Hiſt. de l'Acad.* A. 1701. p. 78.

CAUSES
OF THE
Wholeſomneſs and Unwholeſomneſs
OF THE
AIR.

THE principal thing upon which the wholeſomneſs and unwholeſomneſs of the air depends, is the impregnation it receives from ſubterraneal effluvia. And, tho' this be a cauſe generally overlooked by phyſicians, yet 'tis often very conſiderable in its effects.

The healthy or unhealthy ſtate of the air greatly depends upon ſubterraneal effluvia.

The effluvia that affect the air, may be diſtinguiſhed into ſeveral ſorts, according to their reſpective natures: but I ſhall now only take notice of the differences which may proceed from place and time. With regard to the former, ſome of them ariſe from the cruſt, or more ſuperficial parts of the earth; and others have a deeper origin, aſcending out of the lower parts, and bowels, of the terraqueous globe. And in reſpect of the latter, ſome ſubterraneal effluvia are almoſt conſtantly ſent up into the air, which I therefore call ordinary emiſſions; and others aſcend but at certain times, diſtant from one another; and theſe I call extraordinary emiſſions; whether they come at ſtated ſeaſons, and ſo deſerve the title of periodical; or uncertainly, ſometimes with far greater, ſometimes with much ſmaller intervals; and ſo may be called fortuitous or irregular.

'Tis frequently obſerved, that marſhy grounds, and wet ſoils, are unhealthful, becauſe of the moiſt and crude vapours, that the ſtagnating waters ſend up too plentifully into the air. On the other hand, dry ſoils are generally look'd upon as healthy. And, indeed, theſe obſervations ſeem moſt commonly to hold true: but, beſides what can be juſtly aſcribed to ſuch moiſt vapours, or dry exhalations, in many places the wholeſomneſs or unwholeſomneſs of the air, may be aſcribed to other ſorts of effluvia, from the ſoil, than thoſe that act merely, or, perhaps, principally, either as moiſt or dry.

To deliver my thoughts the more diſtinctly upon this ſubject, I ſhall lay them down in four obſervations, or propoſitions.

PROP. I.

It ſeems probable, that in ſeveral places, the wholeſomneſs or unwholeſomneſs of the air, in the general, may be, in great meaſure, due to ſubterraneal expirations, eſpecially to thoſe I call ordinary emiſſions.

For, in ſome places the air is obſerved to be much more healthy, than the manifeſt qualities of it would make one expect: and, in many of theſe caſes, I ſee no cauſe, to which ſuch a happy conſtitution may more probably be aſcribed, than to friendly effluvia ſent up from the ſoil into the air; which particles, either by promoting perſpiration, or by hindering the production, or checking the activity of morbific ferments; or by mortifying and diſabling ſome noxious particles, that would otherwiſe infeſt the air, *&c.* may greatly contribute to keep the bodies of ſuch as live in that air, in the regular and deſirable ſtate, we call health. I know 'tis generally thought, that mineral bodies ſend up exhalations, hurtful to plants and animals; but when we ſpeak of ſubterraneal things indefinitely, we include more particulars than moſt men are aware of; there being a great number and variety of bodies, that nature has lodged in her ſtore-houſes under the ſurface of the earth. And of theſe differing ſorts, tho' 'tis probable the effluvia of the greateſt part are unhealthful to man, yet there may be others friendly to him. It has been obſerved, that over ſome tin-mines in the weſtern parts of *England*, not only trees, but far more tender plants, proſper and flouriſh; and I have ſeen verdent trees growing juſt over a vein of another ſort of mineral, that lay near the ſurface of the earth: 'tis, likewiſe, obſervable, of ſuch as conſtantly dig in thoſe tin-mines, that they arrive at a great and vigorous age. And an ancient poſſeſſor of ſome of theſe mines aſſured me, that tho' moſt of thoſe viſible fumes had a ſmell that participated of ſulphur, or bitumen, yet others were well ſcented. I remember too, that a friend of mine, and another gentleman, being partners in a chargeable attempt to diſcover a mine; in digging deep for it, they accidentally broke into a vaſt ſubterraneal cavern; into which, becauſe the diggers would not venture, one of theſe gentlemen cauſed himſelf to be let down, and there found the air very temperate and refreſhing; ſo that he long breath'd it with delight: and on the ſoil he diſcovered many and various minerals, moſt of them embryonated, or imperfectly form'd; with plenty of a kind of mineral earth, whoſe ſmell was fragrant, and very pleaſant, both in his judgment, and that of ſome ladies. And, when ſome of thoſe minerals were brought to me, a ſmall lump of this earth that was among them, having now been kept ſo long in the air, as to ſpend moſt of its odoriferous particles, yet the ſmell it ſtill retain'd, was, tho' faint, yet pleaſing.

That from foſſils lying hid under the ſurface of the earth, and having a conſiderable ſpread, there may plentifully aſcend wholeſom effluvia into the air, ſeems to me the more probable, becauſe I obſerved, at a certain place in *Ireland*, a very large ſheep-walk, that produced ſhort, but excellent graſs; the ſpot being juſtly reputed very healthful: the reaſon whereof, from conſidering the circumſtances, ſeemed owing to this, that the ſoil was ſuſtained by a large tract of lime-ſtone, which, I ſuppos'd, continually emitted exhalations into the air: and it has been long and generally obſerved, that as far as the lime-ſtone extends, that tract of ground makes the ſnow which falls on it thaw much ſooner, than on the neighbouring lands.

And a perſon, who had been employed in ſeveral mines, told me, that at a place in *Derbyſhire*, he and others had obſerved, a large tract of lime-ſtone-land to be ſo warm, as to diſſolve the ſnow that fell on it, very much ſooner than another great tract bordering upon it, where the ſoil lay only upon free-ſtone.

An ingenious perſon, alſo, who had viſited the *Hungarian* and *Bohemian* mines, told me, that, during his ſtay among the former, he often walked abroad with the overſeer of them, who delighted to breathe the freſh morning air, upon ſome hills abounding with minerals; and that his guide made him obſerve, when they were over a tract of land which afforded a noble kind of ore, called *Rot-gulden-ertz*, he found the ſmell to be pleaſing, and the air refreſhing. And tho' in paſſing over ſome other mines, he found himſelf moleſted by offenſive fumes, he felt no ſuch effect, when upon that ground under which there ran veins of cinnabar, or a mine of quick-ſilver ore: and his guide told him, that next the *Rot-gulden-ertz*, the ſoil containing theſe cinnabarine veins, was that whoſe air was the moſt eligible for pleaſure and wholeſomneſs. And no wonder, that in ſome places the ſubjacent foſſils ſhould impregnate the air with wholeſom effluvia; for I once ſaw a tract of ground, famous for a good pottery, where, beſides many other mineral earths which I took notice of, there was a groove, that reached fifteen or twenty feet beneath the ſurface of the earth; whence they dug up a kind of white clay, ſo richly impregnated with ſubtile and noble parts, that it afforded a chymiſt or two of my acquaintance, a large quantity of a ſubtile ſpirit, of a volatile and ſaline nature, which, upon trial, they highly extoll'd for its cordial, and other virtues in phyſic; and which, by ſome peculiar mechanical trials I made with it, I concluded to abound with a volatile ſalt, not unlike that of urine or hartſhorn. Since then, ſome ſuſpected foſſils may be enriched with medicinal and fugitive ſalts and ſpirits; it may reaſonably be ſuppos'd, that theſe aſcending into the incumbent air, will

highly

highly conduce to the wholeſomneſs of it. And the chymical examinations I have made of ſome boles, and other bodies, which are unregardedly comprized under the confus'd notion of earths, makes me ſuſpect, that there may be far more ſpecies of ſalubrious foſſils, than are yet taken notice of.

But it will appear the more probable, that ſubterraneal tracts, of great extent, may, for a very long time, ſend up into the air, large expirations, not diſcernable by any of our ſenſes, from conſidering, that the common air wherein we live and breathe, always abounds, and, for many ages, has been impregnated with the plentiful magnetic effluvia of the earth, which our *Gilbert* and others, have proved to be a great, tho' languid magnet; and whoſe emanations, as they conſtantly ſtream thro' the air, are capable of paſſing thro' the pores of glaſs it ſelf, and acting almoſt inſtantaneouſly, yet manifeſtly, upon bodies hermetically ſealed up in it. But, tho' it may hence probably appear, that the wholeſomneſs of the air in ſome places, is chiefly, or at leaſt in part, due to the wholeſom expirations of ſubterraneal bodies; yet, generally ſpeaking, the air is depraved, in far more places than it is improved, by being impregnated with mineral expirations. And, indeed, among the minerals known to us, there are many more noxious, than wholeſom: and the power of the former to do miſchief, is far more efficacious than of the latter to do good; as we may gueſs by the ſmall benefit men receive in point of health, by the effluvia of any mineral, or other known foſſil, in compariſon of the great and ſudden damage that is often done by the expirations of orpiment, ſandarach, and white arſenic. The ingenious perſon, lately mentioned, told me, that when his guide and he walked over ſome veins of theſe noxious minerals, he met with ſeveral odorous ſteams, which, tho' differing from one another, agreed in being all offenſive to him; and, particularly, ſome of them by their ſharpneſs, and others by giving him a difficulty of reſpiration. We may here take notice of the *Averni*, ſaid to be found, ſome in *Hungary*, and ſome in other countries; where there aſcend out of the earth ſuch noxious and plentiful exhalations, as kill the animals that draw in the air they infect; and ſome of them are able to ſuffocate even the birds that fly over them. But there are numerous places, where 'tis leſs manifeſt that hurtful exhalations aſcend into the air. Whole tracts of land, near the ſurface of the earth, ſometimes abound with marcaſitical minerals, as theſe do with a ſharp vitriolic ſalt; which, together with the ill-condition'd ſulphur they alſo plentifully contain, aſcend into the air, and render it corroſive. I once took ſome *Engliſh* ſhining marcaſite, and caus'd a pound of it to be diſtill'd in an earthen veſſel, with a ſtrong fire; by which means, notwithſtanding its dryneſs, I obtained two or three ſpoons-full of a limpid liquor, that ſmell'd very ſtrongly, like *Gas ſulphuris*; and appear'd manifeſtly to be of an acid nature, both by the taſt, and by readily corroding, and diſſolving unbeaten coral, even in the cold. And the mineral afforded me, together with this liquor, about an ounce and three quarters of inflammable ſulphur; part whereof, aſcending in the form of very agile corpuſcles, faſten'd themſelves all about the inſide of the receiver, and there compos'd ſeveral thin coats, or films, as 'twere, of ſulphureous matter ſticking to one another; which, at their being firſt taken off, and for ſome time after, might be bent, or folded like leaves of paper, but afterwards harden'd in the air. Mineraliſts, and credible authors, mention ſeveral places as abounding with marcaſitical foſſils; but I am apt to think, they are far more common than is vulgarly taken notice of: for I have met with them where one would little expect them. And, tho' in *England* all our vitriol be made of vitriolic ſtones, or bodies that paſs for ſtones; yet that is not true which our mineraliſts thence conclude, that there is no other vitriolic or marcaſitical matter in *England*; for a famous dealer in foſſils, having found a mine, which he knew not what to make of, addreſſing himſelf to me, I diſcover'd it to be a vein, that lay at ſome depth under ground, and ran along like a vein of metalline ore, conſiſting of a black and heavy matter; which, upon a few eaſie trials, I quickly found to be ſo far of a vitriolic nature, that, to my wonder, it yielded in a few hours, plenty of pure vitriol, without any troubleſome or artificial preparation.

PROP. II.

It is probable, that, in ſeveral places, ſome endemical diſeaſes, principally, or at leaſt in part, depend upon ſubterraneal ſteams.

By endemical diſeaſes, I do not only mean ſuch as are very peculiar to this or that country; as the *Plica* is ſaid to be to *Poland*, and therefore called *Polonica*; or an odd kind of colic in one part of *France*, from whence 'tis termed *Colique de Poiton*; but alſo thoſe that rage more in ſome countries than in moſt others, as agues in *Kent*, and in that part of *Eſſex* they call the *Hundreds*; the conſumption in *England*; and fluxes of the belly in *Ireland*, where they are ſo common, as to paſs under the name of the country diſeaſe.

That theſe endemical, or local diſtempers, in many places proceed from ſome exceſſive heat, moiſture, or other manifeſt quality of the air; from bad diet, vulgar intemperance, and other cauſes that have little or no connexion with ſubterraneal reeks, I readily grant; but, that in ſome places they may either be principally caus'd, or much fomented by noxious effluvia, I am inclin'd to ſuſpect.

For, 1. There are ſome places, in which the endemical diſeaſe cannot be probably imputed to any manifeſt cauſe; ſince it often happens, that the cauſes aſſign'd of them, if they were true, muſt produce the like diſtempers in many other places, where yet it is notorious that they are not endemical.

2. Subterraneal bodies may ſend up large ſteams, of different kinds, into the air.

3. The materials that ſend up theſe effluvia may be of a large extent. I have ſometimes obſerved, and that in more countries than one, a whole tract of land abounding with minerals of one kind; and at no great diſtance from it, another large tract, whoſe ſubterraneal part abounded with minerals of a very different ſort.

4. 'Tis, alſo, highly probable, from the nature of the thing, that thoſe large ſteams which impregnate the air, may greatly conduce to make it hurtful to a human body, in a way requiſite to produce a determinate diſeaſe. And, ſome parts of the ſubſtance of the air, not only affect human bodies, or, at leaſt, many individuals among them, as they are taken in by reſpiration, but as they outwardly touch the skin: and the skin being full of pores, perhaps of different ſizes and figures, thoſe corpuſcles that get in at them, may have their operation, even upon the moſt inward parts of the body.

'Tis obvious that I here take the air in its more vulgar and lax ſignification, for the atmoſphere, which abounds with vapours, exhalations, and, in a word, with corpuſcles of all ſorts, except the larger kind of ſpringy ones; and many of them may be ſo ſmall, and ſolid, or ſo conveniently ſhap'd, as to enter ſome of the numerous orifices of the minute glandules of the skin, or at other pores of it. Thus, tho' paper be not pervious to the uncompreſs'd elaſtic parts of the air, yet it may be eaſily penetrated by other corpuſcles of the atmoſphere: for, I have prepared a dry body, out of a ſubſtance belonging to the animal kingdom, which being wrapp'd up in paper, would, without wetting or diſcolouring, or any way ſenſibly altering it, paſs in a trice thro' the pores of it in ſuch plenty, as to exert a manifeſt operation on bodies placed at ſome diſtance from it. And, tho' a bladder almoſt full of air, having its neck well tied, be held near the fire in various poſtures, the elaſtical air, tho' rarified, or attenuated by the heat, will rather burſt the bladder, than get out at its pores; yet we have often prepared a certain ſubſtance, belonging to the mineral kingdom, that, if a bladder were wet or moiſt, would readily pervade it, and have a ſenſible effect even upon ſolid bodies placed within it: yet the bladder of urine conſiſts not of a ſingle membrane, and is, probably, of a ſtronger texture, than many other membranes of the body, or the epidermis. But it may be ſaid, 'tis ſcarce conceivable, that in ſo many ages as endemical diſeaſes have afflicted ſome countries, the ſubterraneal matter, to which I, in great meaſure, impute ſome of them, ſhould not be ſpent and exhauſted. And, perhaps, indeed, ſome diſeaſes may have ceaſed, in places where they were once endemical; and others may have appeared in their ſtead. Tho' 'tis very poſſible, that many ſubterraneal bodies, which emit effluvia, may have in them a kind of propagative or ſelf-multiplying power; proceeding from ſome ſeminal principle, or ſomething analogous to a ferment; or elſe ſome maturative property, whereby an inanimate body may gradually admit of ſuch a change, or acquire ſuch qualities, as ſeem perfective of it, and, perhaps, give it a new denomination.

But we know nothing of the nature, or conſtitution, of the lower part of the terreſtrial globe; and but little, experimentally, of what lies beneath that very thin cruſt, to which human induſtry has been hitherto confined. Whence it is not abſurd to ſuſpect, that from the lower ſubterraneal regions, there may be, either continually, or periodically, emitted into the region of mines, great plenty and variety of mineral exhalations, which continually repair the loſs of thoſe, that, from time to time, aſcend out of the foſſil region into the atmoſphere.

But farther, bodies ſo heavy, and conſequently ſo abounding in parts of ſolid matter crowded together, as minerals, and other foſſils, may well be ſuppos'd capable, without great waſt, to emit numerous ſuch minute particles as effluvia, for an exceeding long time. 'Tis ſurprizing, how long ſome load-ſtones, ſever'd from their mine, have been kept in the air, without any ſenſible diminution of their virtue. An eminent phyſician, who was skill'd in perfumes, affirm'd to me, that an adventitious perfume, introduced, by art, into a ſilver watch-caſe which he uſually wore, continued to be well ſcented for ſixteen years. The ſame perſon had a way of perfuming factitious marble quite thorough, whoſe grateful ſcent he affirm'd would laſt exceedingly; and of this perfumed marble he preſented me a ball.

We muſt, alſo, obſerve, that ſubterraneal effluvia may contribute to endemical diſeaſes, not only as they vitiate the air, but as they impregnate or deprave the aliments: for, they mix themſelves with the water, which either men drink, it ſelf, alone, or make into factitious liquors. And that many waters are imbued with mineral corpuſcles, may be judged by ſome of the medicinal ſprings: for, tho' ſeveral *Acidulæ* and *Thermæ* afford a large quantity of palpable ſulphur or ſalt, yet all do not; and having purpoſely examined a famous ſpring, I could, with a pair of nice ſcales, ſcarce diſcover any ſenſible difference between the medicinal water, and the common water that was to be met near the ſame place. And that which impregnated this, and which I found by trial on my ſelf, enabled it to work very manifeſtly like a mineral water, was a ſort of corpuſcles ſo minute and ſubtile, that if the bottles were not kept well ſtopt, they would in a ſhort time vaniſh, and leave the liquor diſpirited. Experience has aſſured me, that there are ways of making common water violently and noxiouſly operative upon human bodies, tho' its ſenſible qualities would not make one ſuſpect any change in it. How little change is made in water, and ſome other liquors, that are render'd ſtrongly emetic by *Crocus metallorum*, and by antimony vitrified without addition? And if ſuch exhalations as ariſe from the *Averni*, ſhould, as they well may, meet either with running, or ſtagnant waters, in their aſcent;

MEDICINE. there is little doubt but they will impregnate them, and make them noxious.

But the effluvia of the lower parts of the earth, may have a greater ſhare in producing endemical diſeaſes, by mixing with the water, and other liquors, that are neceſſary to the nutrition and growth of vegetables, which may thence become unhealthy aliment. And theſe noxious exhalations will, probably, in many places, impregnate the juices of the earth, much more than running or ſtagnant waters; becauſe the difficulty of pervading the earth in their aſcent, may ſo long check them, as to render them very numerous in a ſmall ſpace; and, perhaps, make them convene into bodies, ſo far of a ſaline nature, as to be ſoluble either in common water, or ſome other ſubterraneal liquor; by means whereof, as vehicles, they may inſinuate themſelves into the roots of plants, and be thence conveyed to other parts. A famous chymiſt, who liv'd in a country abounding with mines of vitriol, told me, he obſerved, that the oaks growing over them were remarkably more ſolid and heavy, than thoſe trees elſewhere are. And the parts of ſome minerals are capable of inſinuating themſelves very plentifully into the pores of growing vegetables, without being really ſubdued, by what the philoſophers call the concocting faculty of the plant; whilſt, inſtead of being aſſimilated by the vegetable, they retain their own mineral nature; and upon the receſs, or evaporation of the juice that ſerved them for a vehicle, may ſometimes diſcover themſelves to the naked eye. For, I have ſeen a piece of a vine, that grew not far from *Paris*, which being broken, a multitude of the internal pores of the root, and part of the trunk alſo, appeared to be ſtuffed with corpuſcles of a marcaſitical nature; as was plain by their colour, their ſhining luſtre, and by their weight.

And ſince men feed not upon either beaſts, or birds of prey, but upon ſuch as eat graſs, ſeeds, or other vegetable ſubſtances, and drink nothing but water; the noxious exhalations that render vegetables and water unwholeſom, may, by that means, have a very bad influence upon ſuch animals, as are fed with ſuch depraved vegetables, and drink ſuch noxious waters; and, conſequently, may be very hurtful to thoſe men who eat ſuch animals; and, by the depraved aliment they afford, determine them to that endemical diſeaſe, which ſuch vitiated nutriment is fitted to produce.

'Tis poſſible, alſo, that in certain places the latent minerals may be of ſuch a nature, that their effluvia, inſtead of promoting, hinder the production of ſome particular diſeaſe, whether epidemical, or endemical, in the bodies of the inhabitants. For, as phyſicians obſerve, that the more manifeſt morbific cauſes of ſome diſtempers, are quite contrary to thoſe of others; ſo it ſeems not improbable, that there may, alſo, be a mutual contrariety between theſe latent morbific cauſes, ſent up by ſubterraneal [illegible]ts. And, therefore, it's no wonder, if ſome of theſe ſhould [illegible] diſable ſuch to which they are hoſtile, or ſhould, at leaſt work in human bodies a great indiſpoſition to admit their hurtful operations. And ſince there are ſeveral whole countries, or leſs places, that are either altogether, or in great part, free from this or that particular diſeaſe; as ſeveral parts of *Scotland* from agues, eſpecially quartans; and as in ſeveral large regions of the *Eaſt-Indies*, the plague is very rare; it ſeems not improbable, that the ſubterraneal ſteams may contribute to this advantage, by impregnating the air, the earth, and the water, with corpuſcles of oppoſite qualities to theſe diſeaſes. And this ſeems the more credible, becauſe it has been obſerved, that ſome vaſt tracts of land will neither breed, nor maintain venomous creatures; as is undoubtedly believ'd of the whole kingdom of *Ireland*; where, I confeſs, I neither did ſee any alive, nor met with ſuch as had.

PROP. III.

Many epidemical diſeaſes are, probably, in great meaſure, produced by ſubterraneal effluvia.

It ſeems probable, that ſeveral of thoſe ſudden morbific exceſſes, that are obſerved in the air, may proceed from the unuſual quantity of hurtful exhalations, which aſcend and mix with the air, and diffuſe themſelves through it. We are great ſtrangers to the ſubterraneal part of the globe we inhabit; and there are a great many odd and ſurprizing things to be met with, in the ſtructure and diſpoſition even of thoſe parts of the earth, that lie but a little way beneath the ſurface of it. Whence it ſeems poſſible, that, among the many and various effluviating bodies, that the terreſtrial globe may conceal in its bowels, there are ſome, whoſe reeks, aſcending plentifully into the air, occaſion in it an exceſs of heat, cold, moiſture, thickneſs, or ſome other manifeſt quality. So that, ſometimes, even thoſe manifeſt intemperatures of the air, to which an epidemical diſeaſe is wholly imputed, may, in part, proceed from ſubterraneal bodies; for theſe, by their conflicts, or mutual actions on one another, may excite great and ſudden heats, and, on that account, ſend up ſuch large ſteams into the atmoſphere, as may there produce ſudden and exceſſive heats, lightnings, thunders, *&c.* And ſudden and unſeaſonable refrigerations of the air, may proceed from the action of ſubterraneal bodies upon one another; for trial, purpoſely made, has informed me, that there are certain minerals, whereof ſome may be employed in their crude ſimplicity, and others that require but a ſlight preparation, ſuch as may be had in the bowels of the earth, which being put together, will produce, by their re-action, an intenſe degree of actual cold.

The changes of the air which produce epidemical diſeaſes, are ſometimes ſo great and ſudden, that they cannot, in my opinion, with probability, be imputed to the action of the ſun, or the moon; cauſes that act in too general and uniform a way, to produce thoſe particular and irregular effects; but to ſubterraneal bodies, whoſe actions are often more ſudden, impetuous, and irregular. The difference we find in ſeaſons, that bear the ſame name, and ſhould be alike in temperature, is often very great, and, ſometimes, alſo, very laſting. But the ſun being in the ſame ſigns, at the ſame times of the year, it does not appear, how he ſhould produce ſo great a diſparity of the temperature of the air, in ſeaſons of the ſame denomination. And, doubtleſs, this variety is more rationally attributed to ſubterraneal exhalations, than to the influence of the fixed ſtars, which are ſo vaſtly remote from us; and ſeem too general a cauſe to produce ſuch particular effects as are often confined to a town, or ſome other narrow compaſs; whilſt ſubterraneal bodies are near at hand, of very various natures, and ſubject to many irregular and differing motions, commixtures, re-actions, and other alterations. I have known a great cold, in a day or two, invade multitudes in the ſame city, with violent and fatal ſymptoms; when I could not judge, that the bare coldneſs of the air could ſo ſuddenly produce a diſeaſe ſo epidemical and hurtful: and it appeared the more probable, that the cauſe came from under ground, becauſe it began with a very troubleſome fog.

That there may be many ſubterraneal bodies, which, by their mixtures, wou'd produce a ſudden heat, will be eaſily granted by thoſe who know, that there are ſubterraneal menſtruums; and have ſeen chymical operations, ſuch as the great effervecence, made, when oil of vitriol is put upon filings of iron, or ſpirit of nitre upon butter of antimony, *&c.* And as there is in many places vaſt plenty of marcaſitical matter, beneath the ſurface of the earth, and ſometimes very near it; I have purpoſely tried, that by putting a little ſpirit drawn from nitre, with which ſalt the earth in many places abounds, or a little oil of vitriol, upon powder'd marcaſites, there preſently enſued a ſtrong re-action between the liquid and the ſolid bodies, whereby was produced much heat, with viſible fumes, and ſtrong ſcented exhalations. And ſuch kind of odorous effluvia were emitted, after putting a little ſpirit of ſalt upon our powder'd marcaſites. And becauſe ſulphur is a mineral plentifully met with in the bowels of the earth, and in many places burns there; I ſhall add, that I have found acid ſpirit of ſulphur to work ſenſibly upon marcaſitical matter, hard coagulated. An experienced *German* chymiſt relates, that in ſome parts of his country, he met with vitriol-ſtones, or marcaſites, that, by the action of mere common water, reſting for a competent time upon them, will grow ſo hot, as to enable the liquor to retain a ſenſible heat, when it had paſs'd a pretty way from them. And, as many accidents may occaſion the breaking out of waters, or the change of their courſe in ſubterraneal places; ſo, that common water may, in a very ſhort time, produce conſiderable degrees of heat in mineral bodies, appears by mixing with two or three pounds of fine powder of common brimſtone, a convenient quantity of filings of iron; for this mixture being thoroughly drench'd with common water, will, in a ſhort time, grow intenſely hot, and ſend out a thick ſmoke, like that of good quick-lime, whilſt 'tis ſlaked with water.

A domeſtic of mine, who liv'd in the north of *England*, aſſured me, that in a certain mineral groove, which he had often occaſion to reſort to, the damp would annoy the workmen more than once in one day. And from others, converſant in mines, I learn'd, that in ſeveral places, they were infeſted with damps, that came not at ſtated periods, but irregularly; ſometimes with much greater, and ſometimes with far leſs intervals between them: the times of their duration being alſo often unequal. So that, ſuppoſing ſuch noxious effluvia to be plentifully emitted from the lower parts of the ſoil, it need be no wonder, that an epidemical diſeaſe ſhould rage in a particular town, or part of a country, without ſpreading much farther; and that it ſhould begin ſuddenly in places where it was not expected: for, theſe ſwarms of effluvia being produced by caſual concourſes of circumſtances, may often be excited, and invade this or that place, without giving the inhabitants any warning. And 'tis not always neceſſary, that ſuch noxious effluvia ſhould be generated juſt under the places they moleſt; ſince the motion of the air may ſuffice to carry them to the town or other place that feels their ill effects: and yet they may ſeem to be almoſt confin'd to thoſe places; ſometimes, becauſe the neighbouring parts are not ſufficiently inhabited to make their ill qualities taken notice of; but more frequently, becauſe, by being diffus'd thorough a greater tract of air, they are more diſperſt in their paſſage, and thereby ſo weaken'd, as not to be able to do any conſiderable miſchief.

Nor is it always neceſſary, that the harm done by theſe morbid conſtitutions of the air, ſhould proceed only from ſubterraneal exhalations, merely by virtue of their own qualities, which they bring with them from under-ground. For, 'tis very poſſible, that theſe effluvia may, in their own nature, be either innocent, or at leaſt not conſiderably hurtful; and yet become very noxious, if they chance to find the air already imbu'd with certain corpuſcles fit to aſſociate with them: for, tho' theſe ſorts of particles were, perhaps, neither of them, a-part, conſiderably prejudicial, yet there may from their combinations reſult corpuſcles of a new and very morbific nature. Thus the ſpirituous ſteams of ſalt-petre do not uſually ſenſibly work on gold, no more than the ſpirituous parts that the fire raiſes from ſal-armoniac; yet, when theſe two ſorts of particles unite, there will reſult certain corpuſcles of a new nature, that compoſe the liquor call'd *Aqua regis*; which by its fretting quality corrodes and diſſolves gold.

And as this liquor, being at once poured upon ſilver, gold, diamonds, rubies, *&c.* will leave all the reſt uncorroded, and fall only upon the gold; ſo, the new corpuſcles produced in the air, whether attracted in reſpiration, or entering in at the pores, being carried up and down by the blood, or other fluids of the body, may paſs by ſome parts without doing them any ſenſible harm, and attacking others, there produce ſome diſeaſe, ſuch as the fabric and ſituation of the part peculiarly diſpoſe it to admit.

And this hypotheſis of ours well agrees with the very ſhort duration of ſome epidemical diſeaſes, in certain times and places. For either all the morbific expirations aſcended into the air at once, or, at leaſt, in a ſhort ſpace of time, and ſo were eaſily ſpent; that is, by being diffuſed or diſperſed, too much weakened to do any great miſchief; or elſe the ſubterraneal commotion that produced them may paſs on from one place to another, and ſo ceaſe to afford the air incumbent on the firſt place, the ſupplies neceſſary to keep it impregnated with noxious exhalations. Thus we ſometimes obſerve certain epidemical diſeaſes to have, as it were, a progreſſive motion, and leaving one town free, paſs on to another.

And as ſometimes an epidemical diſeaſe ceaſes in a particular place almoſt as ſuddenly as it invaded the ſame; ſo, according to our hypotheſis it may well happen, that after one ſort of exhalations, whoſe peculiar qualities make them morbific, have deprav'd the air over a particular place; there may, by a new or farther commotion of ſubterraneal bodies, be ſent up large expirations of another kind, which meeting with thoſe that formerly impregnated the air, may either precipitate them, and ſo free the air from them; or by other operations, and ſometimes even by coalitions, ſo alter their nature, as to diſable them from doing any farther miſchief.

Thus in that very remarkable phenomenon, yearly obſerv'd at *Grand Cairo*, it appears, that by the intermixture of adventitious corpuſcles with the peſtilential air, this is ſo alter'd and corrected, that within one day or two, there is a ſtop put to the progreſs of the plague, which, about the middle of ſummer, ſcarce ever fails to rage in that populous city. And theſe friendly corpuſcles operate ſo powerfully, that of thoſe who are already ſeiz'd by the plague, few or none die, after once the air is ſufficiently impregnated with them.

I confeſs ſo great and ſudden a change is very ſurprizing; and I ſhould ſcarce think it credible, had not ſeveral perſons, ſome of them very intelligent, who made a conſiderable ſtay in that city, aſſured me of the truth of it. And the lateſt writer of voyages into *Egypt* relates, that a little after the middle of our *June* (and uſually upon the very ſeventeenth day) there begin to fall, towards the laſt quarter of the night, certain drops of a kind of dew, which cauſes the river to be fruitful, and purifies the air from all infection. He adds, that “the dew purifies the “air; for as ſoon as it falls, the plague ceaſes to be mortal;” and, he ſays, “this dew gives life to every thing; and when it falls upon “the wheat, cauſeth it to continue for many years without corruption, or worms; and renders it far more nouriſhing than that corn on which it never falls. And, therefore, they never houſe the corn of the grand ſeignior till this dew is fallen upon it.”

On the other hand, a very ingenious gentleman, who was owner of ſome mines in *Devonſhire*, told me, it ſometimes happens that, of a ſudden, a conſiderable tract of ground will be as 'twere blaſted by the aſcending fumes; ſo that not only the graſs, fern, and other more tender vegetables, will be turned black, and, as it were, burnt or ſcorched up; but now and then trees alſo, and even oaks themſelves, will be blaſted and ſpoiled by the powerful operation of theſe ſubtile and poiſonous effluvia.

The propagation, effects, and phenomena of the plague.

'Twill be expected I ſhould here take ſome particular notice of peſtilential fevers and the plague. The former, indeed, may probably ariſe from noxious effluvia of the earth: but as for the true plague, I am at a loſs for its origin; however, its propagation and effects ſeem chiefly to be carry'd on by a malignant diſpoſition in the air; without which, ſome plagues could never have been ſo contagious, nor ſo ſuddenly mortal: and that this malignant diſpoſition in the air, may, probably, be in great part imputed to ſome kinds of ſubterraneal expirations, I am apt to think, for the following reaſons.

And firſt, none of the ſeveral cauſes to which the plague is uſually imputed, ſeems ſufficient. The malevolent aſpects and influence of the celeſtial bodies ſuppoſe ſome things very difficult to be prov'd, and are agents too remote, too general, and too indeterminate, to be acquieſc'd in as the cauſes of ſuch particular ſymptoms and phenomena, as often accompany the peſtilence. And as for internal putrefaction, exceſſive heats, noiſome ſmells, corrupt aliments, *&c.* the learned *Diemerbroeck*, tho' his own hypotheſis ſeems to be more theological than philoſophical, has greatly weaken'd their force in this caſe.

But farther, by conſulting ſome uncommon authors, travellers, and navigators, I learn, that ſeveral great countries are uſually free from the plague; which, according to the vulgar hypotheſis, ought to be as much ſubject to it as others. *Leo Africanus* informs us, that ſome parts are ſo ſeldom afflicted with the plague, that it uſually ſpares the inhabitants for twenty-nine or thirty years together. And he expreſly records, that in *Numidia* it ſelf, notwithſtanding the raging heat of the climate, the plague is produc'd but once in a hundred years. Our *Purchas* informs us, that in the land of the *Negro's*, it is not known at all. And, to omit what ſome travellers and navigators relate of *Japan*, as if it were ſeldom or never invaded by the peſtilence; I do not remember, that in *New-England*, which contains a great extent of land, that the *Engliſh* take any notice of the plague, ſince their firſt ſetling there. Sir *Philibert Vernatti* writes from *Batavia*, “that the plague is a diſeaſe unknown to the *Indians*.” And of the countries that lie yet more remote, as the great empire of *China*, and the kingdoms of

Tunquin, and of *Cochinchina*, *Alexander de Rhodes*, who ſpent thirty years in thoſe parts, affirms, that the plague is not ſo much as ſpoken of there; yet the ſame jeſuit, upon probable grounds, eſtimates the number of the people of *China* alone, to be two hundred and fifty millions; a number I take, by far, to exceed that of all the Nations of *Europe*.

Now conſidering what vaſt tracts of land are compriz'd in thoſe countries, ſome of which the plague does not at all, and others but very unfrequently, invade; we have a ſtrong argument againſt the generality of opinions received among phyſicians; as alſo that of *Diemerbroeck* himſelf, who derives the plague from a ſupernatural cauſe, the provok'd wrath of God. For, in regions of ſuch extent, and many of them very populous, lying in different climates, and ſome of them inhabited by nations who make war with numerous armies, fight bloody battels, leave heaps of unburied bodies expoſed to the putrefying heat of the ſun, are ſometimes forc'd to live upon very unwholeſom foods, who worſhip ſtocks, ſtones, beaſts, and ſome of them devils, who are, at leaſt, as guilty as *Europeans*, of aſſaſſinations, poiſonings, rapes, *&c.* in theſe regions; I ſay, 'tis not imaginable but that great intemperatures of the air, eſpecially in point of heat, ſtench of dead bodies kill'd in fights, unwholeſomneſs of aliments, malevolent aſpects of celeſtial bodies, high provocations of the divine juſtice, and, in ſhort, all the cauſes, to one or other of which the ſeveral parties of phyſicians refer the plague, ſhould be wanting any more than in *Europe*; yet the plague, which is preſum'd to be the effect of one or other of thoſe cauſes, is not here obſerved to be produc'd.

If theſe hiſtorical facts be alledged, alſo, againſt our hypotheſis, I deſire it may be conſider'd, that my opinion about the plague conſiſts of two parts; one, that 'tis exceeding difficult to aſſign the true and adequate cauſe of its origin; and the other, that whatever be the cauſe of its firſt eruption; its propagation, and many of its ſymptoms, may be, probably, refer'd to the depravation of the air by ſubterraneal ſteams, and their effects: whence, theſe hiſtorical obſervations will appear to confirm the firſt member of our hypotheſis. And as to the ſecond; ſince in the *Eaſt-Indies*, and other countries, where the plague is not obſerved to break out, it cannot be pretended, that ſubterraneal effluvia there promote the propagation of it; no more can it be prov'd, that they could not, in caſe the plague were begun by other cauſes. But as I think it probable, that ſometimes the plague is not only fomented, but begun by noxious expirations of the terreſtrial globe, I ſhall add, that this ſuppoſition is not abſolutely inconſiſtent with the preceeding obſervations. For firſt, it may be ſaid, that ſome of the countries I ſpeak of, are deſtitute of thoſe noxious minerals to which we impute ſome plagues. Thus tho' ſulphur be uſually found in many countries, and that in plenty, where there are other metalline veins, yet in the mines of *England*, I never met with ſo much as an ounce of native ſulphur; and I could not find that ſeveral mineraliſts, of whom I purpoſely inquired, had met with any, among the various mines they had frequented. There may, alſo, happen to be noxious minerals in a country, that are not often capable of producing or promoting peſtilences there, even upon moderate earth-quakes. For, 'tis poſſible, that theſe orpimental, or other noxious minerals, may have their beds, or veins ſo deep in the earth, that they are not ordinarily able to ſend up effluvia, ſtrong and plentiful enough to make a peſtilential depravation of the air; and, in leſſer earth-quakes, the commotion or agitation of the ground, may not reach ſo far downwards, as much to affect theſe very deep mines; and yet ſome other more violent ſhocks may affect even theſe: whence one may give a tolerable account, why the plague in ſome parts of *Afric*, has been obſerved to rage but once in thirty, or once in an hundred years; for there may be periodical paroxyſms, or grand and vehement commotions, in ſubterraneal parts, tho' men have not yet obſerved them. A late judicious *French* hiſtorian records, that a very pernicious diſeaſe, of the nature of a colic, reigned in *France*, every tenth year, for a long tract of time. And *Platerus* relates, that at *Baſil*, where he practiſed phyſic for fifty-ſix years, the city was afflicted with furious plagues, once in about every tenth year, for ſeventy years together. It may farther be ſaid, that thoſe exhalations in the *Eaſt-Indies*, &c. which wou'd otherwiſe be peſtiferous, may be corrected by other expirations, either of a benign nature, or of ſuch an one, as, tho' noxious in themſelves, may fit them, by combining with the others, to diſable and prevent their ill effects; as *Beguinus* tells us, that a country abounding in veins and maſſes of cinnabar, which is the ore of quick-ſilver, was preſerved from the plague, when the neighbouring regions were waſted by it. And tho' corroſive ſublimate be ſo miſchievous a mineral compoſition, that a few grains may kill a man; yet the fumes of this combined with thoſe of crude, common quick-ſilver, which are themſelves unwholeſom, make *Mercurius dulcis*, an uſeful and innocent medicine.

It might, likewiſe, be alledged, that in ſuch regions, the ſoil, and other aſſiſtant cauſes, may conſtantly produce in the air a conſtitution like that in the air of *Egypt*, during the time of the increaſe and overflowing of the *Nile*; which uſually laſts every year for ſeveral weeks; during which time, the air is wholly anti-peſtilential.

Our conjecture, alſo, will afford a probable account of ſome conſiderable things, relating to the production and phenomena of the plague.

'Tis obſerved, that ſometimes the plague breaks out, when no immoderate diſorder of the air, or any caſual enormity, capable of producing ſo great and irregular an effect, has happen'd. Nay, it has been obſerved, that very great and unuſual intemperatures of the air, have often happen'd, and many notable and threatning aſpects of the ſtars, without being followed by the plague. *Fernelius* relates,

Medicine. that the year, which of all in the memory of man, was all the world over the moſt immoderately hot, yet proved moſt healthful. And the ſame author reports the plague to have begun in the midſt of winter, and to have gone off in ſummer; and that, ſeveral times, ſcorching ſummers have been altogether free from the plague; which I, likewiſe, have obſerved to be true. *Johannes Morellus* tells us, that in his country, after a dry winter, wherein the north wind reign'd, tho' it were ſucceeded by a moſt temperate and healthful ſpring, yet this brought in the plague; and that too, when the north wind was predominant, and the air pure and ſerene. And I obſerved ſomething very like it, in the conſtitutions of the air, that preceded and accompanied the dreadful *London* plague in the year 1665. Now, theſe phenomena much diſcredit their opinion, who impute the plague to the exceſſes of the manifeſt qualities of the air; but are agreeable to our hypotheſis, ſince noxious ſubterraneal fumes may be ſuddenly, and without any warning, raiſed up into the air; and, by depraving it, produce fatal diſeaſes in many of thoſe perſons who are conſtantly ſurrounded by it, and draw it in, almoſt every moment, with their breath.

Of the deadly effect of ſeveral ſubterraneal expirations, at their firſt eruption, there are many hiſtories extant in approved authors: and we have obſerved inſtances of that ſort, in the times and countries we live in. But, becauſe all poiſonous, and even mortal exhalations, are not, therefore, truly peſtiferous, but may, like many other poiſons, kill the perſons they immediately invade, without qualifying them to infect others; I ſhall add a paſſage out of M. *de Mezeray*, who relates, that "the plague which happened in *France*, in the year 1346, was ſo "contagious, that ſcarce a village, or even a houſe, eſcaped uninfected "by it. This peſtilence," he ſays, "was the moſt furious and wide-"ſpreading that had been known, and began two years before in the "kingdom of *Cathay*, by a vapour moſt horribly fetid, that breaking "out of the earth, like a kind of ſubterraneal fire, conſumed and "devoured above 200 leagues of that country, even to the very trees "and ſtones; and infected the air in a wonderful manner." He adds, that "from *Cathay*, it paſs'd into *Aſia* and *Greece*, thence into *Afric*; "and afterwards into *Europe*, which it ranſack'd throughout."

In the next place; there is a wonderful diverſity obſerved in ſeveral countries, and even in the ſame country, at different times of thoſe raging diſeaſes, that phyſicians call the plague; whence it happens, that ſuch medicines, or methods of cure, as are in one plague ſucceſsful, do often in another prove dangerous: which great variety may be fairly accounted for, by the great number and diverſity that has been actually found, or may be reaſonably ſuppos'd, in the numerous minerals, and other bodies, in the ſubterraneal regions; eſpecially if we conſider, that the number of ſuch bodies may be much increaſed and diverſified, by various combinations made of them by caſualties, ſubterraneal fires, and menſtruums. And the aſcending corpuſcles of thoſe mineral bodies, being moſt of them ſolid and ſubtile, may produce in the blood, and ſo in the body, far more odd and violent ſymptoms, than the peccant humours that beget ordinary diſeaſes. Which may be one reaſon, and perhaps the chief, why the ancients, and *Hippocrates* himſelf, acknowledged in peſtilential diſeaſes, ſomewhat of divine, ſurpaſſing ordinary nature.

What theſe mineral ſubſtances are, whoſe ſteams produce ſuch odd and diſmal ſymptoms, ſeems exceeding hard to determine. Yet, if I were to name one ſort, I ſhould think the leaſt unlikely to be orpiment. For, of the poiſonous minerals we are acquainted with, I know not any whereof there is a greater quantity in the bowels of the earth; many of whoſe miſchievous effects ſeem to agree with the ſymptoms of ſome plagues, and may be gueſſed to have, at leaſt, a conſiderable ſhare in producing them. Yet I do not think that theſe minerals are the cauſes, even of all thoſe peſtilences, whoſe efficients may be ſubterraneal: for ſeveral reaſons, and ſome drawn from experience, make it probable, that the ſubterraneal regions have many kinds of very pernicious foſſils, of which phyſicians, and even chymiſts, have no knowledge, nor diſtinct names; and that the various aſſociations of theſe, which nature may by fire and menſtrua make under ground, and, perhaps, in the air it ſelf, will very much increaſe the number and variety of noxious materials, and alſo heighten their hoſtility to human bodies. Thus, the factitious white arſenic, commonly ſold in ſhops, tho' uſually made of orpiment, by the addition of ſo innocent a body as common ſalt, (which is found in great plenty under ground) is obſerved to be far more poiſonous than orpiment it ſelf. And a skilful chymiſt, having in my preſence, taſted ſome prepared arſenic, was quickly invaded by ſuch ſymptoms, as he thought would ſoon kill him. But I preſently put him out of danger, tho' not out of pain, by early preſcribing him plenty of oil of ſweet almonds, and ſomething made of lemmons, that I chanced to have by me. And ſandarach ſeems to be but orpiment, whoſe yellow colour is deepned to redneſs; as native arſenic ſeems to be little other than pale or white orpiment. And, indeed, in *Hungary*, all three may be found not far from one another, in the ſame mine; as I learn'd from an eye-witneſs, by whoſe means, and thoſe of another chymiſt, ſeveral native orpimental minerals, (to ſay nothing of realgar, becauſe it is a factitious combination of orpiment and ſulphur) came to my hands. But tho' this ſort of foſſils are more numerous and various than is vulgarly obſerved, yet the very noxious effects of the effluvia of orpiment, are not unknown to phyſicians: and the learned *Sennertus* gives a particular inſtance of it in a painter, who, upon opening a box where orpiment, which men of his profeſſion uſe as a pigment, had been long kept, was thereby caſt into fainting fits, and had his face much ſwell'd. And, as white arſenic is of a more piercing and corroſive nature, ſo it were eaſy to ſhew, out of the writings of eminent phyſicians, that its effects have

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often proved very hurtful, and ſometimes mortal, tho' but externally worn in amulets; eſpecially if the pores of the skin were opened by exerciſe and ſweat. And the nature of the ſymptoms produced, ſeems to confirm our hypotheſis; ſince the perſons who wore theſe arſenical amulets were affected, ſome with great anxieties about the heart, ſome with inflammation, ſome with burning fevers, ſome with exulcerations of the breaſt, ſome with puſtules, like thoſe of the plague; and theſe were ſometimes black, as if made with a cauſtic. Moſt patients of this kind were affected with great weakneſs and faintneſs, *&c.* as if they had ſwallowed poiſon; and of one young man 'tis recorded, that having heated himſelf in a tennis-court, with an amulet upon his breaſt, the virulence of its corpuſcles made him fall down dead upon the ſpot. And 'tis a conſiderable circumſtance in theſe obſervations, that ſeveral patients were cur'd of the ſymptoms, that ſeem'd peſtilential, by the ſame remedies that are alexipharmic againſt the plague; whence it may, alſo, be made probable, that the plague it ſelf, many times, is a natural, tho' a dreadful and irregular diſeaſe; ſince its effects and ſymptoms ſo much reſemble thoſe of acknowledged poiſons, and have been cured by antidotes effectual againſt them.

An ingenious man, who ſometimes viſited a mine known to abound with orpimental foſſils, told me, that when he walked over the neighbouring grounds, he found himſelf much diſordered, eſpecially in his thorax, by the effluvia; and that the mine-men and diggers were ſubject to a malignant, irregular, and dangerous ſort of fevers; tho' he ſaid he was apt to impute it, in ſome meaſure, how truly I know not, to their drinking too much ſtrong wine. But, tho' 'tis probable, the effluvia of orpimental bodies may have a great intereſt in ſeveral plagues, yet, I ſtrongly ſuſpect, that many others may proceed from the ſteams of ſuch ſubterraneal bodies, as are not yet diſtinctly known to us; and, poſſibly, have their effluvia variouſly combined, either beneath, or above the ſurface of the earth. I have ſeveral times, and that without heat, combined fumes of differing kinds, ſeparately inviſible, into manifeſtly viſible ones, in the free and open air.

And that the ſubterraneal effluvia may produce effects, and, therefore, probably, be of natures very uncommon, irregular, and exorbitant, appears from thoſe prodigious croſſes that were ſeen in the year 1660. in the kingdom of *Naples*, after an eruption of *Veſuvius*. For theſe croſſes appear'd on linen that had lain open to the air; becauſe, as *Kircher* fairly conjectures, the mineral vapours were, by the texture of that, eaſily determined to run along in almoſt ſtrait lines, cutting each other; and, conſequently, to frame ſpots, reſembling ſome one, and ſome other kinds of croſſes. Theſe were extremely numerous in ſeveral parts of the kingdom of *Naples*; whence the jeſuit, who ſent the relation to *Kircher*, ſays, that he himſelf found thirty in one altar-cloth; that fifteen were found upon the ſhift-ſleeve of a woman; and that he reckoned eight in a boy's band: Their colour and magnitude were alſo very unequal, and their figures different; they would not waſh out with ſimple water, but required ſoap; their duration was likewiſe unequal, ſome laſting ten or fifteen days, and others longer, before they diſappear'd. And theſe croſſes were found not only upon linen garments expos'd to the air, but upon ſome of thoſe that were kept lock'd up in cheſts.

A pious and learned ſchool-maſter, who ventured to ſtay in *London* during the great plague in 1665; and was much employed to viſit the ſick; and went indiſcriminately to all ſorts of infected, and even dying perſons, aſſured me, that being once called to a poor woman, who had buried ſome children of the plague, he found the room ſo little, that it ſcarce held any more than the bed whereon ſhe lay; and an open coffin, wherein he ſaw her husband lie dead of the ſame diſeaſe, whom the wife ſoon after followed. In this little cloſe room, 'twas affirmed to him, that the contagious ſteams had produced ſpots on the very wall. He alſo declared himſelf to have obſerved the like in his own ſtudy, which being divided only by a wall, from ſome rooms of a houſe, which the owner had turned into a kind of a peſt-houſe, and in which numbers had died in a ſhort time; he took notice that the white wall of his ſtudy was (ſince the ſickneſs raged) blemiſhed in ſeveral places with ſpots, like thoſe of infected perſons. Inquiring what antidote he us'd againſt the infection, he reply'd, a ſpoon-full of brandy, five or ſix times a day, eſpecially when he went into infected places, and a ſmall piece of the root of *Spaniſh* angelica, which he held in his mouth as often as he thought neceſſary.

But tho' I fear phyſicians will not be able to diſcover all the ſubterraneal bodies, whoſe effluvia produce or contribute to the plague; yet I do not think it impoſſible, that by diligent obſervations and trials, ſagacious men may diſcover ſeveral of them; and, perhaps, antidotes againſt them.

In the late great plague, that ſwept away ſo many thouſands at *London*, there remained in the city an ingenious phyſician, bred by the learned *Diemerbroeck*, and who twice had the plague himſelf, whereof he ſhew'd me ſome effects; and told me, that notwithſtanding many and various trials, he ſtill found abundance of his patients die, after the buboes, carbuncles, or peſtilential tumours appeared; becauſe, upon a little refrigeration of the body by the air, and often by the very fear that diſheartned the patient, the tumours would ſuddenly ſubſide; when the peſtilential matter, recoiling upon the vital parts, would quickly diſpatch the fatal work. He therefore bethought himſelf of a method, by means of which he aſſured me, he had not loſt one patient of very many he treated; if he could but, as he uſually did, by good alexipharmic and cordial remedies, enable and excite nature to expel the peccant matter into a tumour; for then he preſently clapp'd on an appropriated drawing-plaiſter, which would never ſuffer the tumour to ſubſide, but break it, or make it fit for opening, and thereby give nature a convenient vent, at which to diſcharge the matter that oppreſs'd her. This plaiſter was no other than the *Magnes arſenicalis* of *Angelus Sala*, mixt up with the warm gums. And if it prove as ſucceſsful in other plagues, as it did to thoſe who us'd it in that of *London*; there will be juſt cauſe to admire the providence, which, in a poiſonous mineral, that, probably, often concurs to produce the plague, has laid up a remedy for it.

An ancient and very experienc'd phyſician, to whoſe care a great peſt-houſe was committed, where, by the contagion, he loſt three phyſicians, his aſſiſtants, and three chirurgeons of four who were under him, told me, that his conſtant antidote was, only to take every morning, faſting, a little ſea-ſalt diſſolv'd in a few ſpoonfuls of fair water.

And a very learned phyſician, having once recommended to me an herb, little noted in *England*, as a moſt effectual and experienced antidote againſt the plague, I caus'd it to be cultivated in a garden, and when the peſtilence raged moſt ſeverely in *London*, I ſent ſome of it, made up with a little ſugar, in the form of a fine green conſerve, to two infected perſons, who, both of them recover'd. But having made only thoſe two tryals, I dare not relie much upon them; however, I uſually keep the plant growing in a garden, becauſe both the taſt and colour are pleaſant; and becauſe ſome little experience has invited me to believe the commendations I have found given of it againſt the bites of venomous creatures: about which there is a notable inſtance recorded by *P. Spehrerius*, of a *Roman*, who having, with his ſtaff, cruſh'd a viper that he took to be dead, had ſo ſtrong a venom tranſmitted along the ſtaff to him, that on the enſuing night, he found a very great inflammation in both his lips, which was followed by a vehement burning fever, and ſtrange torture; from all which he was ſtrangely relieved by the juice of goats-rue. It may without diſguſt be taken plentifully, in its entire ſubſtance, in the form of a ſalad, a conſerve, or, a ſyrup, or elſe in its juice, newly expreſs'd.

It, likewiſe, agrees with our hypotheſis, that ſometimes the plague ceaſes, or at leaſt greatly abates of its contagion and malignity, in far leſs time than phyſicians could rationally expect. For ſometimes it may happen, that, tho' the conſtitution of the air continues the ſame, the matter that afforded the peſtiferous exhalations, may be either ſpent under ground, or altered by combination with other ſubterraneal bodies, or by ſome of thoſe many accidents that may happen, wholly unknown to us, in thoſe dark receſſes. And if once the fountain of theſe noxious effluvia be ſtopt, ſo that thoſe in the air ceaſe to be recruited; the wind and other cauſes may, in a ſhort time, diſſipate them; or at leaſt dilute them with innocent air, ſo far as to keep the diſeaſe, they produc'd, from being ſo miſchievous as before. And it may often happen, that, tho' the minerals which emit the hurtful expirations, remain where they were under ground, and be not conſiderably waſted, yet their fatal effects may not be laſting; becauſe the effluvia were generated by the conflict of two or more of them, which vehemently agitated one another, and ſent up fumes, that ceas'd to aſcend, at leaſt in great plenty, when the conflict and agitation ceas'd. Thus, by putting good ſpirit of ſalt upon filings of ſteel or iron, in a convenient glaſs, a great conflict will be made between them; and without the help of external heat, there will be ſent up into the air large viſible fumes of a very ſulphureous odour, and eaſily inflammable; and this elevation of fumes will leſſen or ceaſe, as does the tumultuous agitation that produc'd them. So, likewiſe, if you pour *Aqua fortis* upon a convenient proportion of ſalt of tartar, there will, at firſt, be a great ebullition produc'd; and, whilſt that continues, great, red and noiſome fumes will be elevated, but not long outlaſt the commotion of the mixture, whoſe active parts ſoon combine into a kind of nitrous ſalt, wherein the noxious parts of the menſtruum are clog'd and hinder'd from evaporating or aſcending, tho' really they retain much of their priſtine nature.

It may, alſo, happen, that ſoon after the commotion of ſubterraneal matter, which yielded peſtiferous exhalations, a more intenſe degree of ſubterraneal heat, or perhaps the ſame latent fire, extending it ſelf farther, may force up fumes of another ſort, that, being of a contrary nature, may prove antidotal to the former; and, by precipitating them, or combining with them, diſable them from acting ſo miſchievouſly as they otherwiſe would. I have ſometimes purpoſely made diſtillations, in which one part of the matter being, after the operation was ended, put to the other, there enſued a ſudden and manifeſt conflict between them, and ſometimes an intenſe degree of heat. And that mineral exhalations, tho' otherwiſe not wholeſom, may diſarm peſtiferous effluvia, appears from that obſervation of a country, which abounding with veins of cinnabar, was, probably, by their expirations, preſerved from the peſtilence. And our hypotheſis will, perhaps, appear the more probable, from the ſudden check that is almoſt every ſummer given to the plague, which at that time reigns at *Grand Cairo*. For, ſince 'tis generally obſerved, that morbific cauſes operate much more effectually than curative ones; it ſeems very probable, that exhalations aſcending from under ground into the atmoſphere, may be able to produce peſtilential fevers, and the plague it ſelf; ſince thoſe corpuſcles that impregnate the *Egyptian* air upon the ſwelling of the *Nile*, put a ſpeedy ſtop not only to the contagion, but to the malignity of the plague, aſſiſted even by the ſummers heat, which at *Grand Cairo* is exceſſive.

MEDICINE. If from good *Corniſh* tin, you warily diſtil an equal or double weight of *Venetian* ſublimate, into a very large receiver, very well luted on to the retort, you will obtain a ſpirituous liquor, which, as ſoon as the free air comes to touch it, will, very long, ſend up abundance of white exhalations in the form of a thick ſmoak: and tho' this liquor be thus apt to emit ſmoak, not only plentifully, but, as one would think, with violence, yet even when I put it into an open veſſel, if I did but lay a piece of a ſingle leaf of paper upon the orifice of the glaſs, ſo as to cover it all, the viſible production of the fumes would preſently ceaſe; and the liquor lie like common water, as long as the paper remained, tho' lightly upon the glaſs; but upon the removal of that, the liquor would ſend up plentiful fumes as before: which ſeems to argue, that ſome metalline ſubſtances may, by the contact of the air, have their copious aſcent into the atmoſphere very much help'd and promoted, as if the air had ſaline, or other ſort of particles in it, that, with regard to ſome mineral bodies, are of a very volatilizing nature.

We diſſolved copper in good *Aqua fortis*, till the menſtruum was ſatiated with it; in the ſtrong ſolution, we ſteep'd, for a while, ſome brown paper, that being fitter than the finer to ſoak up the liquor; then ſlowly evaporating the ſuperfluous moiſture, we put a quantity of this imperfectly dry'd paper upon the hearth, at ſuch a diſtance from a fire of actually flaming wood, that the paper was not kindled, yet ſo ſcorch'd, as to afford very plentiful fumes; which looked like ordinary ſmoke, whilſt they moved through the air. But when the motion of the air towards the flame, had carried theſe fumes to it, they diſcloſed their nature; for, being actually kindled, they tinged the flame of a lovely colour, for the moſt part blue, and ſometimes green, as they happen'd to be variouſly mixed with the flame and ſmoke of the wood.

THE NOTION OF Specific Remedies

Prov'd agreeable to MECHANICAL PHILOSOPHY:

With the advantages of ſimple Medicines conſider'd; and their Uſe recommended.

SECT. I.

THE ſpecific virtue of medicines, is an occult quality that well deſerves our conſideration. For, it not only excites our curioſity, and nearly concerns our health; but may, perhaps, prove of much greater importance than is commonly imagined. And an enquiry into this abſtruſe phenomenon, ſeems to me the more neceſſary, becauſe many learned phyſicians reject the mechanical philoſophy for being, as they fancy, irreconcileable to the notion of ſpecific remedies; or, at leaſt, unable to give any tolerable account of their operation.

Specific qualities, what.

I find three ſorts of qualities mentioned in the writings of phyſicians, under the notion of ſpecific virtues. By ſome of them a medicine is ſaid to have a ſpecific quality, becauſe it is eminently and peculiarly beneficial to a particular part of the body, as the heart, the brain, the eyes, *&c.* Others ſay, that a ſpecific remedy attracts and evacuates ſome determinate humour, as choler, phlegm, *&c.* But the moſt uſual account, upon which a medicine is ſaid to be ſpecific, is, that by ſome hidden property it cures this or that particular diſeaſe; as a pleuriſy, an aſthma, the colic, dropſy, *&c.* And this being the principal and moſt common ſenſe, wherein the word ſpecific is employed by phyſicians, I ſhall, hereafter, commonly make uſe of it in that ſenſe; yet without confining my ſelf ſo ſtrictly thereto, as not to conſider it in the other two, when occaſion ſhall require.

But, before I deſcend to particular conſiderations, I previouſly declare, that by a ſpecific medicine, I do not underſtand one that will cure a diſeaſe infallibly and univerſally; for, I confeſs, I never yet met with any ſuch remedy. Nor do I, by a ſpecific medicine, mean one that, like a charm, works only by ſome latent and unaccountable property, without the aſſiſtance of a known quality. But by ſpecific, I here denote a medicine, that moſt commonly, and better than ordinary means, gives conſiderable relief to the patient, by acting principally upon the account of ſome peculiar virtue; ſo that if it have any benign manifeſt quality, yet the ſervice it does is greater than can reaſonably be aſcribed to ſuch a degree of the manifeſt quality it poſſeſſes; whether it prove hot, cold, bitter, ſudorific, *&c.*

Whether there be really any ſpecific virtue in medicines.

Two grand queſtions may be propoſed, about the ſpecific virtues aſcribed to medicines; as firſt, whether they really exiſt; and, ſecondly, if they do, whether they can be mechanically accounted for.

The former of theſe queſtions admits of a double meaning; for it may be propos'd with reſpect either to the preſent meaſure of our knowledge, or to the future attainments of mankind.

In the latter ſenſe, I ſhall not maintain, without reſtriction, either part of the queſtion. For I am apt to think, that the future induſtry and ſagacity of men, will be able to diſcover intelligible cauſes of moſt of thoſe qualities, that now paſs for occult; and among the reſt of many ſpecific virtues aſcribed to medicines; yet, on the other ſide, poſterity will not be ſucceſsful in tracing out the true and immediate cauſes of thoſe good effects of ſome remedies, that depend upon too fine and uncommon textures, and too latent and irregular motions, to fall under the ſenſes, tho' aſſiſted by inſtruments. And this ſeems the leſs improbable, from conſidering thoſe ſtrange peculiarities of diſpoſition in the bodies of particular perſons, that are mentioned in the books of eminent writers. Some few of theſe, indeed, may be plauſibly accounted for; yet I do not think the like explications applicable to others.

As to the former ſenſe of the queſtion, I confeſs my ſelf very inclinable to the affirmative; as far as I can judge by ſuch writings of phyſicians, as I have peruſed. This limitation I add, becauſe I wou'd not derogate from the knowledge of particular perſons, who may have arrived at far greater attainments, than thoſe who have entertained the public about the occult and ſpecific qualities of medicines.

I know there have been, and ſtill are, dogmatical phyſicians, who, upon the principles of the ſchool-philoſophy, reject all medicinal virtues, that they think not reducible to manifeſt qualities. But of ſuch *Galen* juſtly complains, that they either deny matter of fact, or aſſign very incompetent cauſes of the effects they pretend to explain. And, for my part, I am ſo far from believing theſe men capable of giving ſufficient reaſons of the more hidden properties of medicines, that I think them unable, by their principles, to give clear and particular explanations, even of the more eaſy and familiar virtues of ſimples.

Arguments for the exiſtence of ſpecific remedies.

I am, therefore, of opinion, that in my ſenſe of the term ſpecific, there are ſpecific remedies. To this opinion I have been led by ſeveral reaſons. And, firſt, it has the ſuffrage of many learned phyſicians, both ancient and modern, and particularly of *Galen* himſelf, in ſeveral parts of his works; who, treating of a ſpecific for the bite of a mad dog, whoſe virtue he aſcribes to an occult quality; or, as he ſpeaks to the propriety of the whole ſubſtance; he takes occaſion to promiſe a diſcourſe upon things, which operate in that manner. And, tho' in matters of philoſophy, I am little ſway'd by mere authority; yet the concurrent teſtimony of many eminent phyſicians, may, in this controverſy, be the more conſiderable, becauſe moſt of them having been noted practitioners, had opportunity to obſerve, whether or no any remedies deſerv'd the name of ſpecifics. And their teſtimony is the ſtronger in this caſe, becauſe phyſicians are uſually very unwilling to acknowledge, there are effects which fall under the cognizance of their art, whereof they cannot aſſign the cauſes.

My next inducement to admit ſpecifics, is founded upon parity of reaſon. For 'tis manifeſt, that many formidable diſeaſes are produced by inconſiderable quantities of poiſons; which have not been diſcovered to produce ſuch great and tragical effects, by any manifeſt quality, whether firſt, ſecond, or third; as phyſical authors diſtinguiſh them.

On this occaſion I ſhall add a very odd accident, about which I was conſulted by an expert oculiſt, very ſoon after it happen'd. The caſe was this. A man, as he lay in bed, happening to ſee a great ſpider juſt over his face, caus'd it to be ſtruck at, whilſt he continued ſtedfaſtly to look at it. Upon which the animal, either frighted, or irritated by the blow, let fall a drop of liquor into one of the man's eyes; who finding no heat, nor ſharpneſs enſue, but rather a very ſenſible coldneſs, regarded it not; but preſently after happening to rub the other eye, he was ſurprized to find he had wholly loſt the ſight of that wherein the ſpider let ſomething fall.

But to return; the great miſchief done to the human body, by very ſmall quantities of poiſon, ſeems to argue, that appropriated medicines, eſpecially when adminiſtred in a larger quantity, may produce very conſiderable changes to the advantage thereof. I here expect to be told, that 'tis much eaſier to do harm than good; and, I confeſs, 'tis true in general; but in the particular caſe before us, I conſider that ſome poiſons, which produce dreadful ſymptoms in the body, are frequently cured by their reſpective antidotes; which, therefore, muſt have a ſanative power, great enough, with the help of the ordinary concurrence of nature, to ſurmount the efficacy of the venomous matter. And, as perfumes often produce various, frightful ſymptoms, in hyſterical women; ſo the ſcent of burnt feathers do frequently remove them, in as little time as the ſweets produc'd them. And I have often found the ſmell of ſtrong ſpirit of hartſhorn, or of ſal-armoniac, recover ſuch women much more ſuddenly, than the fragrant odours gave the diſorder.

The third and principal inducement I have to allow of ſpecific remedies, is from experience. I might urge, on this occaſion, the teſtimony of *Galen*, who tells us more than once, that he himſelf, therefore, confided in the aſhes of burnt craw-fiſh, to cure the bite of a mad dog, becauſe never any of thoſe who took it died. And, by the way, he declares, that tho' the effect of theſe aſhes be admirable, even when given alone; yet their virtue may be increas'd, by adding to ten parts of them, five of gentian, and one of frankincenſe.

I here purpoſely forbear to mention ſuch medicines, as are by ſome learned phyſicians commended for ſpecifics, but queſtion'd or denied by others. It may ſuffice to take notice of two or three, whoſe efficacy is more notorious.

'Tis known, by daily experience, that in *Italy*, and other hot countries, tho' the ſtings of ſcorpions often produce very acute pains, and formidable ſymptoms, yet the miſchief is eaſily remedied, either by preſently cruſhing the body of the ſcorpion upon the hurt, or by anointing the part affected with oil of ſcorpions; which being made by ſuffocating thoſe inſects in common oil, and keeping it long in the ſun, the liquor does not appear to have any manifeſt quality, to which its ſanative efficacy may be aſcribed.

The bite of thoſe ſerpents, which, becauſe of the noiſe they make with a kind of empty bladders in their tails, we call rattle-ſnakes, are accounted much more poiſonous and dangerous than the ſting of ſcorpions. And yet when the *Engliſh* planters in *Virginia*, where they greatly abound, are bitten by theſe ſerpents, they very ſucceſsfully cure themſelves by the uſe of *Virginia* ſnake-weed.

That the *Peruvian* bark is a ſpecific againſt agues, particularly quartans, many learned phyſicians allow; and I remember, the famous Dr. *Willis* ſaid, in a private conference, "'tis the nobleſt medicine we know." But tho' I will not diſpute, whether it be ſo certain and ſafe a ſpecific for agues, as 'tis believed by ſome, yet it can ſcarce be deny'd to be a ſpecific medicine to ſtop the fits of agues; for it does that far more effectually, than the generality of phyſicians, for many ages, could with their other febrifuges.

I my ſelf have ſeen a ſtone, of ſurprizing efficacy in ſtopping hemorrhagies; and another which performed extraordinary things in more than one diſtemper; tho' I could not perceive that either of them acted by any manifeſt quality.

The reaſons urged againſt ſpecifics conſider'd.

I know, that thoſe who have rejected ſpecific medicines, confidently urged three plauſible arguments againſt them. Some phyſicians deny, that there are any effects of medicines ſo conſiderable, as to make them deſerve the name of ſpecific. Others would probably allow, that experience favours our opinion, did they not think the manner of a ſpecifics operation inexplicable, and therefore unworthy to be admitted by phyſicians. And, laſtly, others again will allow them to be very efficacious, but endeavour to derive their whole efficacy from manifeſt qualities, as heat, cold, tenuity of parts, the faculty of making large evacuations, *&c.*

But there is one argument that may be objected againſt ſpecific remedies, ſo ſpecious, as to deſerve a particular examination; leſt it ſhould, if unremoved, beget too ſtrong a prejudice againſt us. It may be ſaid, that a medicine taken in at the mouth, muſt in the ſtomach and inteſtins, be very much chang'd by digeſtion, and the aliment it meets with there; and a good part of it, be thrown off with the excrements; that, after it has paſs'd the ſtomach, it muſt meet with ſeveral ſtrainers of different textures, which will, probably, ſtop moſt of the medicinal particles that ſhould pervade them; and, that if any ſhall be ſo lucky, or ſo penetrating, as to ſurmount all theſe obſtacles, they will, probably, either be aſſimilated into the ſubſtance of the body, or be quite alter'd by the parts they muſt there combine with: or if any ſo obſtinately retain their priſtine nature, they will, in all likelihood, be too few to have a conſiderable operation upon the body. But to this plauſible objection, I have ſeveral particulars to oppoſe, by way of anſwer.

And firſt, many ſpecific medicines, as ointments, plaiſters, poultis's, amulets, pericarpia, *&c.* being outwardly apply'd; their particles may get into the maſs of blood, without paſſing thro' the ſtomach; and, conſequently, are not concerned in the preſent objection. (2.) Againſt moſt of the *Galenical* phyſicians, who urge this objection, 'tis arguing *ad hominem*, to remind them, that the ſame, or as great difficulties, clog a common opinion of their own: for, ſince they ſuppoſe, that purgatives, cordials, diaphoretics, beſides cephalics, hepatics, *&c.* contemperate and ſweeten the blood, and uſefully affect the reſpective ſolid parts, to which they are adapted; and ſince theſe medicines act not by bare qualities, but by ſmall particles of their own ſubſtance; if they can give us an intelligible account of the admiſſion of particles, in conſiderable numbers, into the receſſes of the body, without being deprived of their particular virtues, they will, at the ſame time, inſtruct us how to anſwer the objection they urge againſt us. (3.) And, as the generality of phyſicians hold, that milk and urine were materially in the maſs of blood, and ſeparated from it by the breaſts and kidneys; I think the invalidity of their arguments againſt ſpecifics, appears from experience. For, 'tis obvious, that rhubarb tinges the urine of thoſe who take any conſiderable doſe of it. And in ſome of our *American* colonies, there grows a pleaſant red fruit, which the planters call the prickled-pear, whoſe juice is of ſo penetrating a nature, that it paſſes from the ſtomach into the bladder, and thence comes out with ſo little loſs of colour, that ſtrangers, who have eaten thereof, are ſurprized and frighted at their own urine; ſuppoſing it to be blood. As for milk, the great *Hippocrates* himſelf informs us, that if a woman, or a ſhe-goat, takes *Elaterium*, the cathartic virtue of it paſſes into that fluid, and purges the child who drinks it. And during my ſtay in the confines of *Switzerland* and *Savoy*, I obſerved, that when the cows in that diſtrict fed, as they uſually do in the middle of ſummer, upon a certain weed, ſaid to be a kind of wild garlic, the butter made of their milk had a very rank taſt of the herb. And I remember too, that paſſing a winter on the ſea-coaſt of the county of *Cork* in *Ireland*, I found it a known obſervation there, that a ſort of greedy ſea-fowl, living almoſt wholly upon fiſh, thereby acquired a taſt, that makes ſome pleaſantly queſtion, whether the food they afford be fleſh or fiſh. (4.) Laſtly, the objection that ſo ſmall a quantity of a ſpecific, as retains its nature when it arrives at the ſeat of its operation, muſt have little virtue left, will not ſtagger thoſe who know how unſafe it is to meaſure the power of natural agents, to work upon ſuch an engine as a human body, by their bulk, rather than by their ſubtilty and activity.

A ſober gentleman, who was governour of a colony in the torrid zone, and had ſailed far up the river *Gambra* in *Africa*, aſſured me, that the blacks had a poiſon, ſlow and mortal, the doſe whereof is ſo ſmall, that they uſually hide enough to kill a man under one of their nails; from whence they very dextrouſly convey it into any liquid aliment, for the perſon they deſign it. He added, that in another part of *Africa*, a famous knight, who commanded the *Engliſh* there, and lately died in his paſſage home, was in this manner poiſon'd by a young *Negro* woman of quality.

I could name a vegetable ſubſtance growing in *England*, which, tho' ſome empirics employ as a medicine, is ſo violent in its operation, that a learned and famous modern phyſician declares, half a grain would cauſe very dangerous hypercatharſes; which have ſometimes proved mortal.

And becauſe many ingenious men deny, that our *Engliſh* vipers are poiſonous; I ſhall add, in favour of the argument I have been enforcing, that I know a young man, who having been bitten by an *Engliſh* viper, which he raſhly took hold of, tho' the tooth only prick'd his hand; and the venom, convey'd by ſo ſmall a hurt, perhaps equall'd not, in quantity, the hundredth part of a pin's head; yet it quickly produced dreadful ſymptoms in him; and, among others, a violent vomiting. A perſon, alſo, whom I knew, that practiſed phyſic in the iſle of *Java*, where ſcorpions are held to be more venomous, having been ſtung in his thumb, by a ſcorpion, tho' the wound was ſo ſmall that I could not obſerve the leaſt ſcar it had left, it put him preſently to moſt exquiſite torture, which continued for ſome hours; during which he felt ſo raging a heat within, that, to uſe his own expreſſion, he "thought hell-fire was got into his body:" and thus he continued, till he procured the proper ſpecific. Nor is it only by mere poiſons that a human body may be greatly affected, tho' the agent be very inconſiderable as to bulk and weight; for we ſee, that women, otherwiſe ſtrong and healthy, will be caſt into ſwooning fits, ſuffocations, and convulſive motions, by the odours of musk and civet; tho' if all the effluvia that cauſe theſe ſymptoms, were reduced into one aggregate, it would not, probably, amount to a hundredth, nor, perhaps, to a thouſandth part of a grain. Thus, alſo, an inconſiderable quantity of the effluvia of volatile ſalt and ſpirit, preſently allay theſe violent ſymptoms. And as for internal remedies, 'tis vulgarly known, that in the infuſion of *Crocus metallorum*, the corpuſcles that render the liquor vehemently emetic and purgative, are ſo very minute and ſubtile, that great proportions of wine, or other vehicles, may be ſtrongly impregnated thereby, without any ſenſible diminution of the body that affords them. And of this we have, perhaps, a more conſiderable inſtance, when quick-ſilver is boiled, or long infuſed in common water. For, *Helmont* obſerves, that tho' the liquor be not alter'd in colour or taſt, nor the quick-ſilver at all ſenſibly changed, nor grown any thing lighter on the balance; yet the liquor, by means of theſe inſenſible and unponderable effluvia of the quick-ſilver, acquires a notable virtue againſt worms; for which purpoſe, not only *Helmont*, but others, extol it. And I remember, that a fine boy, born to be heir to a very illuſtrious family, falling into a dangerous fever, which was judged to proceed from worms, or verminous matter; the famous and experienced phyſician, who treated him, confeſs'd he had no hopes of him; becauſe the child, bred to have his will, and being tired with unſucceſsful remedies, was ſo obſtinate, as to drink nothing but ſmall beer. Whereupon I adviſed his beer to be impregnated with mercurial particles, by frequently ſhaking pure quick-ſilver therein. By which means, the patient perceiving no change of colour, nor taſt in the drink, ſwallowed it greedily, and ſoon after recover'd.

I ſhould condemn my ſelf for having beſtowed ſo many words upon one objection, but that I hope the anſwer given to it in this place, will facilitate and ſhorten our future task.

Whether the notion of ſpecifics may be accommodated to the mechanical philoſophy.

Having then diſpatched the firſt of our two enquiries, I proceed to conſider, whether the mechanical hypotheſis can be accommodated to the notion of ſpecific medicines, ſo as to explain their operation, either intelligibly, or prove it agreeable thereto.

And here I muſt freely confeſs, however ſuperficial our knowledge may be, and however abſtruſe and veil'd the operation of ſpecifics; yet, conſidering the large extent, and great fertility of the mechanical philoſophy, I cannot deſpair that ſeveral effects of ſuch medicines, may, in a general method, be explain'd by it.

But before I come upon this explanation, let it be obſerved, once for all, that I content my ſelf, on moſt occaſions, to give only poſſible explications; and to ſhew, that ſpecific medicines may operate in the manner I propoſe; without affirming that to be the very manner in particular caſes; becauſe we need not grant, that the operations of all ſpecifics, or of the ſame, in different diſeaſes, muſt be of one kind: for, different ſpecifics may operate in ſeveral manners; and ſome by one means may cure one diſeaſe, and others another. Nor need the ſpecific remedy always relieve the patient, by this or that ſingle manner of operating, but by a concurrence of two or more, that, as it were, join their forces to produce the deſired effect.

For a foundation to the following propoſitions, it muſt be remember'd, that an animated human body is not a mere ſtatue, or congeries, of the materials 'tis compos'd of; but an admirably fram'd engine, conſiſting of ſolid, liquid, and pneumatic ſubſtances, ſo exquiſitely adapted to their reſpective functions and uſes, that the effects of an agent upon it, are not commonly to be meaſured by the power of the agent, conſider'd in it ſelf, but by the effects conſequently produced from the action of the parts of the living machine upon one another.

PROP. I.

A ſpecific medicine may cure, by diſcuſſing or reſolving the morbific matter, and thereby fitting it for expulſion thro' the greater outlets of the body, and the cuticular pores.

'Tis known, that many obſtinate chronical diſeaſes often proceed from viſcid humours, that obſtruct the canals wherein the blood ſhould circulate, or other uſeful fluids be tranſmitted. And theſe peccant humours are often ſo tenacious and obſtinate, that ordinary remedies will have little effect upon them. But a ſpecific may, by the ſmallneſs and ſuitable figure of its corpuſcles, get thro' the pores into the receſſes of this ſtubborn matter; and thus, by their ſolidity, figure, and agitation, promoted by the heat of the patient's body, diſſolve and ruin the texture of the morbific matter, and render it capable of being naturally proſcribed by urine, ſweat, or ſome other commodious and innocent evacuation. Thus, the blood, or other fluid of the body, being impregnated with the benign and operative particles of the remedy, becomes an appropriated menſtruum to the peccant matter. Thus ſal-armoniac may be diluted into a menſtruum, that, by degrees, will diſſolve both copper and iron. The menſtruum, in this caſe, muſt be appropriated, becauſe there is no ſufficient reaſon to ſuppoſe, that it works by any manifeſt quality, as heat, moiſture, *&c.* or even by acidity: but rather, by virtue of the fitneſs, which the ſhape, bulk, ſolidity, and other mechanical properties of its particles, concur to give it, to ſhake aſunder the parts of a body of ſuch a determinate texture. For there are many more

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diſtinct ſorts of menſtrua than are commonly taken notice of; and the operations of theſe cannot ſafely be meaſured by the ſtrength of their manifeſt qualities; ſince it may often happen, that a menſtruum, leſs acid, or leſs ſtrongly taſted, may diſſolve this or that body, which another menſtruum, that ſeems far ſtronger, will not work on. Thus cold water will diſſolve the white of an egg, which pure ſpirit of wine, oil of vitriol, or ſpirit of ſalt, will coagulate. Thus rectified ſpirit of urine, will readily diſſolve minute filings of copper, which ſpirit of vinegar will but ſlowly corrode; and yet this liquor will ſpeedily diſſolve crabs eyes, which ſpirit of urine will leave entire. Thus quick-ſilver, that is inſipid, will, without heat, diſſolve gold, which *Aqua fortis* it ſelf, tho' aſſiſted by fire, will not touch; and yet *Aqua fortis* will furiouſly tear aſunder the parts of iron, tho' quick-ſilver will not ſo much as adhere to its ſurface. And thus, in ſhort, common oil, that is ſo ſmooth upon the tongue, and will not corrode ſo much as an egg-ſhell, will diſſolve brimſtone, which reſiſts *Aqua fortis* it ſelf, that diſſolves almoſt all metals, beſides many hard ſtones and minerals. And I have prepared a liquor, which, tho' ſo weak that one may ſafely drink a wine-glaſs full of it, pure, will yet operate on ſome very hard bodies, both ſtones and metals, in a way that is not to be match'd among the highly corroſive menſtrua uſed by chymiſts.

And now, ſuppoſing that the active corpuſcles of a ſpecific medicine, aſſociated with the blood, or other vehicle, may act upon the morbific matter they meet with, in the manner of a menſtruum, we may illuſtrate ſeveral particulars with regard thereto.

And, firſt, we may hence conjecture, why an appropriated medicine will perform, what another cannot; tho' its manifeſt qualities ſeem to be of the ſame kind, and much ſtronger in degree. For, menſtrua do not always act according to the degree of their acidity, or the like ſenſible quality, but according to the congruity of their parts, to the pores of the body they are to diſſolve; and frequently, alſo, according to a fitneſs that depends upon other mechanical properties of the acting liquor. And, therefore, phyſicians, as well as others, may eaſily miſtake, in arguing *à majori ad minus*, and *à minori ad majus*. For, becauſe water will diſſolve gum arabic, therefore that highly rectified ſpirit of wine, which is a much more ſubtile and penetrating liquor, muſt diſſolve gum arabic, is a falſe concluſion: or thus, becauſe ſtrong oil of vitriol is more corroſive to the taſt, and will diſſolve many bodies that *Aqua fortis* will not, therefore that it will diſſolve ſilver as well as *Aqua fortis*, is falſe, and the contrary true. Nay, this is not a juſt inference; *Aqua fortis* diſſolves ſilver by virtue of its acid ſpirits; therefore the more it abounds with theſe, the more powerfully will it diſſolve that metal: for, if *Aqua fortis* be made exceeding ſtrong, it will not work upon ſilver, but readily, after it has been weakned by the addition of a fit quantity of common water.

To all this I might add, that the diſſolution of a body may depend, as well upon the peculiar texture of the body it ſelf, as the manifeſt ſtrength of the menſtruum.

2. This doctrine may ſuggeſt the reaſon, why a medicine, that has a great effect in one diſeaſe, proves ineffectual in another, apparently of kin to it, and perhaps leſs obſtinate. For, the preſumed analogy between them may not be ſo great, but that ſome diſſimilitude of texture in the morbific matters, may render the one unfit to be wrought upon, by the ſame menſtruum that diſſolves the other. Thus, tho' pure ſpirit of wine will eaſily diſſolve gum guaiacum, and the little portions of reſinous matter that are harboured in the pores of the wood; yet the ſame menſtruum will not work upon the wood of the tree that affords theſe ſoluble ſubſtances.

3. This may keep it from appearing ſtrange, that ſpecific medicines ſhould ſometimes fail of their deſired effects. For, as the bodies of individual patients may greatly differ, either in their natural conſtitution, that they acquire by the diſeaſe, or in both; ſo 'tis not ſurprizing, that in ſome ſick perſons, among many, the congruity between the agent and patient ſhould be alter'd, either by a conſiderable change in the texture of the morbific matter, or ſome alteration that the corpuſcles of the medicine receive in their paſſage thro' the veſſels, by the admixture of ſome incongruous particles of the blood, or other vehicle. Thus both ſpirit of ſalt, and that of nitre, will diſſolve copper, and the latter ſilver; yet if you mix the other with ſpirit of ſalt, which, by its like operation upon copper, ſeems of the ſame nature, the ſpirit of nitre will be no longer able to diſſolve ſilver, as it would before.

4. Our hypotheſis may, alſo, hint an anſwer, to one of the chief and moſt plauſible objections produced againſt ſpecific medicines. 'Tis ask'd, how a medicine can poſſibly rove up and down in the maſs of blood, and, neglecting whatever elſe it meets with, ſingle out and faſten upon the morbific matter to be proſcribed. Why, if the medicine acts by impregnating the blood, or ſome other fluid of the body, and turning it into a kind of menſtruum, 'tis very poſſible that the ſtrainers, thro' which the corpuſcles muſt paſs, may keep back the inconvenient parts of the vehicle; and, which is in our caſe more conſiderable, that the menſtruum may be either appropriated to the peccant humour; or elſe, at leaſt, be qualified to reſolve that more eaſily, than any other ſubſtance it meets with in the body. Thus if bone-aſhes, *Crocus martis*, ſaw-duſt, powder'd ſea-ſalt, and filings of gold, be blended all together, and afterwards divided into two parcels, and upon one you pour common water, it will readily diſſolve the ſalt, and leave the other ingredients untouch'd; and if upon the other part of the ſame mixture, you put a ſufficient quantity of quick-ſilver, and rub them together, this metalline liquor will only faſten upon the gold. And thoſe who work in the *Spaniſh* gold-mines inform us, that when they have well ground

ſome ore that contains gold and copper, beſides heterogeneous minerals, well heated quick-ſilver will take up the gold, much ſooner and better than it will the copper; which it ſcarce meddles with, as long as there remains any conſiderable quantity of gold to be wrought upon. As for the ſuppoſed difficulty, that the medicine ſhould ſearch out the morbific matter, in what part ſoever of the body it lies; this objection might have been conſiderable, before the diſcovery of the blood's circulation: but now we know, that whatever gets into the maſs of blood, is preſently whirl'd about with it; and may, therefore, be convey'd even to the remoteſt veſſels.

5. Our hypotheſis, alſo, may help us to anſwer thoſe many learned phyſicians, who either reject or deſpiſe moſt external remedies, eſpecially pericarpia, amulets, and appenſa, upon a ſuppoſition, that they can neither communicate to the body any ſtore of medicinal particles, nor reach internal diſeaſes; eſpecially when ſeated in parts remote from thoſe whereto the medicine is applied.

But we need here only conſider, what abundance of particles, ſenſible to the noſtrils, are, for a long time, emitted by a ſmall quantity of amber-greaſe, or of camphire; and the multitude of magnetical corpuſcles, that, for many years, conſtantly flow from a ſmall vigorous load-ſtone; to make it appear poſſible, that even dry and ſolid bodies may afford ſufficient ſtore of effluvia, to produce conſiderable effects in ſo curious an engine as the human body. And as to the ſecond part of the objection; the moſt eminent modern phyſicians allow the poroſity of the skin, whereat 'tis very poſſible for the ſubtile effluvia of ſeveral bodies to enter; and when theſe have once got admittance into the ſmaller veſſels, 'tis eaſy to conceive, how they will thence be carried into the greater; and, conſequently, into the maſs of blood; by whoſe circulation they may be readily tranſmitted to all the parts of the body, and ſo to the ſeat of the diſeaſe. And, perhaps, the efficacy of theſe corpuſcles may be the more conſiderable, becauſe they get preſently into the maſs of blood, without undergoing thoſe digeſtions in the ſtomach, and other parts, which oftentimes greatly weaken the virtue of medicines, taken in at the mouth, before they arrive at the blood.

PROP. II.

A ſpecific may ſubdue the too great proportion of acid, or other luxuriant particles, in the maſs of blood, and prevent their coagulatory, or other pernicious effects.

Tho' I cannot impute almoſt all diſeaſes to acidity in the blood, and other fluids of the body, by means whereof the ſolids are alſo offended; yet, I readily grant, that a conſiderable number of diſtempers may chiefly proceed either from acids themſelves, or their bad effects. And, accordingly, we may very probably conceive, that ſeveral diſorders may be either quite cured, or greatly leſſen'd, by a ſpecific, that abounds in corpuſcles fitted to obtund acids. Now, ſuch an effect is producible by more ways than one, but the principal that now occur to my thoughts are theſe two.

Firſt, there are ſome bodies that mortify, or diſable acids, by a poſitive hoſtility, or ſuch a contrariety, as is diſcernable by the taſt, the viſible conflict, and manifeſt tumult produced when they invade each other. Such bodies are thoſe called alcalizate ſalts; whether fixed, as the lixiviate ſalts of plants, or volatile, as the ſpirits, and aſcending ſalts of urine, blood, hartſhorn, *&c.* as may be exemplify'd by mixing any of theſe with *Aqua fortis*, ſpirit of ſalt, oil of vitriol, or the like acid liquors. Whence, by the way, we may ſee, that thoſe *Galeniſts* miſtake, who aſcribe the virtues of ſpirit of hartſhorn, and of urine, only to their tenuity of parts, briskneſs of motion, and the like properties; that they might not ſeem obliged to the chymiſts for ſo uſeful a notion, as that of the contrariety of acids and alkalies.

The other principal means by which acids may be mortified, is, by being ſheath'd; for an acid corpuſcle may loſe its power of cutting or pricking, either by having its figure ſpoiled by the action of a ſtrong and manifeſt alkali; or elſe by being cover'd in a porous body, that, perhaps, is endowed with no taſt, or any other manifeſt quality. Of this way of mortifying acids, chymical operations afford us many inſtances; as when minium deſtroys the acidity of ſpirit of vinegar, chalk that of *Aqua fortis*, and *Lapis Calaminaris* that of ſpirit of ſalt, and even of ſpirit of nitre. And I the rather mention *Lapis Calaminaris*, becauſe its qualities are leſs known to phyſicians, and the generality of chymiſts; and becauſe it ſupplies me with an argument, to prove that acids may be rather ſheathed than deſtroyed, by the bodies that ſilently mortify them. For, as *Glauber* juſtly obſerves, acid ſpirits may, by the force of fire in diſtillation, be driven out of that ſtone very much dephlegmed, and ſtronger than before.

I know it may be here objected, that the mortification of acids is performed by a manifeſt quality; and therefore proves nothing in favour of ſpecific medicines. But to this I anſwer, firſt, that the power of mortifying acids, by ſheathing them, or by abſorption, is none of thoſe qualities, whether firſt, ſecond, or third, that the *Galeniſts* allow in medicines; tho' their ſufficiency to cure diſeaſes, has been, and ſtill is urged by many, againſt the ſpecific virtues of remedies. Secondly, that it is an unhappy and dangerous miſtake, that ſo many learned modern phyſicians ſhould take it for granted, that if a medicine be endowed with a manifeſt quality, its good or ill effect may be aſcribed to that quality, whether it be acid or alkaline; for there is a conſiderable difference, as various trials have aſſured me, between one acid and another, and between one alkali and another: 'tis fit, therefore, to diſtinguiſh betwixt an acid, as merely ſuch, and the peculiar modification that may belong to that acid. Thus, tho' all acid menſtrua, that I know of, will, if they be well dephlegmed, diſſolve copper; yet *Aqua Regis*, that diſſolves not only copper, but gold, will not touch ſilver; as, on the other ſide, *Aqua fortis* will not, of it ſelf, diſſolve gold; but if you give it a new modification, by adding to it common ſpirit of ſalt, which, as I have often found, leaves that metal entire, the *Aqua fortis* will eaſily diſſolve it. Nay, a different modification may not only cauſe a difference between acids, but what would commonly be called a contrariety; for ſpirit of ſalt will precipitate ſilver, which *Aqua fortis* has diſſolv'd; and ſpirit of nitre not only precipitates an antimonial powder out of that odd ſubſtance, butter of antimony, but does it with a ſurprizing conflict, tumult, and effervеſcence; yet this butter of antimony is ſo highly acid, that a little quantity of it turns a conſiderable one of water ſo ſour, that many chymiſts call ſuch a mixture *Acetum Philoſophorum*.

To apply all this to the propos'd objection; I at firſt plainly intimated, that a ſpecific medicine might ſometimes operate, in part, by a manifeſt quality, tho' the good effect it produced, were not due, barely to the kind or degree of that manifeſt quality, but to ſomewhat ſuperadded, upon which its ſpecific virtue, in a particular diſeaſe, depends. And, accordingly, it may be ſaid, that as there are ſeveral kinds of acids and alkalies, too, 'tis not every acid that will be mortified by every alkali, and thereby have its effects deſtroyed; which may be illuſtrated from hence, that tho' when copper is diſſolved in *Aqua fortis*, 'tis poſſible, by the help of mere chalk, ſkilfully applied, to make the menſtruum let go the corpuſcles of the metal; yet if, upon ſuch a high colour'd ſolution of copper, you ſhall pour a due quantity of ſpirit of urine, or the like volatile alkali, tho' there will preſently enſue a great conflict, and manifeſt ebullition, with noiſe and numberleſs bubbles, yet between theſe hoſtile ſalts, a multitude of the acid corpuſcles of the *Aqua fortis* will not be ſo mortified, as to let go the metal; but the ſolution, varying its colour, will acquire a deeper than before.

And when I conſider the differences to be found between vinegar, alum, cryſtals of tartar, juice of lemmons, juice of barberries, the eſſential ſalts of ſour plants, &c. I am apt to think, that nature, in diſorder, may produce, in a diſeaſed body, acids of ſeveral ſorts, which are not particularly known to us; and that ſome of theſe may have ſuch a peculiar diſpoſition, that our common alkalies will prove unable to diſſolve them; which yet may be conquer'd by ſheathing them with ſome appropriated, or peculiarly modified corpuſcles of a ſpecific remedy. This may be illuſtrated from hence, that tho' neither ſpirit of vinegar, ſpirit of ſalt, nor oil of vitriol, would, as far as I have try'd, diſſolve a ſtone taken out of a man's body; yet ſpirit of nitre, which leaves untouch'd ſome bodies that oil of vitriol will diſſolve, would readily work upon it, and thereby loſe its corroſiveneſs.

There are two things that I would have remarked, before I leave this ſubject. One of them is, that preternatural acids not only diſaffect the body, whilſt they continue ſenſibly acid; but, in many caſes create diſtempers, whereof moſt men would think them the remedies. For, tho' acids be reputed to have an inciſive and reſolutive virtue, and are, therefore, preſcribed to cut tough phlegm, and to diſſolve coagulated blood; yet, as I readily grant this virtue to acids in ſome caſes, ſo there are others, wherein I greatly ſuſpect, that obſtructions, and their conſequent diſeaſes, may be occaſioned by the ſame; as they coagulate ſome fluids in the body, which are thereby rendred unfit to paſs with the reſt of the blood, thro' the ſmaller veſſels and ſtrainers of it. This I ſhall exemplify by the coagulation produced, by adding ſpirit of ſalt, to the white of an egg, reduced to an aqueous conſiſtence; and the like may be eaſily effected in milk, which not only ſpeedily curdles with ſpirit of ſalt, but, as is vulgarly known, with runnet, juice of lemmons, *&c.* And experiments, purpoſely made, have ſhewn, that if ſome acids be conveyed immediately into the maſs of blood, they will coagulate that fluid it ſelf, whilſt it continues in the veſſels of living animals.

The other particular I deſire ſhould be here obſerved, is, that tho' acid corpuſcles are, by ſome modern phyſicians and chymiſts, ſuppos'd hurtful, both in the blood, and ſeveral ſolid parts of the body; and tho' ſome ingenious men impute almoſt all diſeaſes to the bad effects of acids; yet I am very inclinable to think, that many diſeaſes and ill ſymptoms proceed from corpuſcles, that, whether of a ſaline nature, or not, differ from acids properly ſo called. For bodies may, as 'twere, reſult from the combination of acids with other ſaline particles, that much alter their nature. Thus, ſpirit of ſalt will, with ſpirit of urine, compoſe a kind of ſal-armoniac; and ſpirit of nitre, with ſalt of tartar diſſolv'd in common water, will con-coagulate into ſalt-petre, or a body exceedingly like it; and the ſame ſpirit of nitre, or *Aqua fortis*, with ſpirit of urine, or of blood, or the like, will afford a very fuſible ſalt, very different from either of the ingredients, before their conjunction. And 'tis vulgarly known, that oil of vitriol, and oil of tartar *per deliquium*, produce, by their coalition, *Tartarum vitriolatum*; in which, both the acid and the alkali are very much infringed; the third body produced greatly differing from either of the liquors. And conſidering how many different ſorts of corpuſcles nature may have form'd, that, without being acid, may yet have notable and pernicious effects upon the blood, or ſome particular ſolid of the body; it ſeems probable, that other qualities are required, to mortify or diſable theſe morbific corpuſcles, than a contrariety to acid ſalts; and, conſequently, that a medicine, whoſe parts are peculiarly fitted to correct, or enervate a particular ſort that is noxious, may deſerve the name of a ſpecific.

But further, as various coagulations may be made in the body by ſaline corpuſcles, manifeſtly acid, ſo others are producible by corpuſcles, whether ſaline in taſt or no, that are not manifeſtly acid, but, perhaps, of a contrary nature; which obſervation, tho' uſually overlook'd by phyſicians, is, in my opinion, of no ſmall importance, and therefore may deſerve to be more fully made out. I have, ſometimes, prepar'd a liquor, that was not, in taſt, either acid or urinous; whereto having put a moderate proportion of diſtill'd liquor, which alſo was, in taſt, neither acid, urinous, or lixivious, it would, in a few minutes time, be coagulated into ſo firm a body, that, tho' the open wide-mouth'd veſſel, that contain'd it, was held with its orifice downwards, nothing would fall out thereat.

And if, upon a certain ſolution, ſome ſpirit of urine, or another volatile alkali, be let fall, there will preſently be produc'd a gelly, whoſe conſiſtence, and colour, may make it eaſily miſtaken for common boil'd ſtarch.

The like gelly, but more tranſparent, I have alſo made without the help of any thing ſenſibly acid, or urinous. And, to ſatisfy ſome virtuoſi, I have ſhew'd them, to their ſurprize, a ſubſtance which I could preſently prepare, without urine, or any volatile alkali, that would immediately coagulate about twice its weight of highly rectified, and inflammable ſpirit of wine, into a ſolid maſs.

And, to manifeſt that 'tis not requiſite that a liquor be ſenſibly acid, to coagulate an animal ſubſtance, as I lately obſerv'd the ſpirit of ſalt did the white of an egg, highly rectified ſpirit of wine will do the ſame thing as well, if not better.

PROP. III.

A ſpecific may prove ſerviceable, by precipitating the peccant matter out of the blood, or other fluid of the body.

Tho' precipitation be frequently a conſequence of the mortification of acids, or of alkalies, by corpuſcles of a contrary quality, yet I thought fit to ſay ſomething of it a-part; becauſe I have obſerv'd, that ſome acids and alkalies may be put together, without cauſing any precipitation by their contrariety: and, on the other ſide, that various precipitations may be produced, where there does not appear any hoſtility; though, I know, this effect is often thought a ſufficient argument of a preceding conflict of acids and alkalies; but that ſhould be prov'd by collateral experiments.

To proceed to our own examples. I know ſeveral urinous ſpirits, that will mix with acid menſtrua, without any manifeſt conflict or precipitation; and, on the other hand, ſome acids and alkalies, that will make a manifeſt conflict by their mutual re-action, yet, if mingled in a juſt proportion, there will be a manifeſt coalition, inſtead of a precipi-

Medicine. tation; as may be exemplified in certain quantities of ſpirit of ſal-armoniac, made with ſalt of tartar, or pot-aſhes, and ſpirit of nitre, or *Aqua fortis*; and alſo by ſpirit of urine, and ſpirit of ſalt, mix'd in a certain proportion; whereby they convene into corpuſcles, for the making of ſal-armoniac, which the phlegm of thoſe liquors will keep ſwimming. But, what makes moſt for my preſent purpoſe, there may be precipitations, where no tumult, or contrariety, appears; as when ſilver, being diſſolv'd in *Aqua fortis*, and the menſtruum diluted with 30 or 40 parts of diſtill'd water, if clean plates of copper be immers'd in the ſolution, the ſilver will be very ſlowly precipitated out of it, in the form, not of a calx, conſiſting of metalline and ſaline parts incorporated together, but in the form of pure ſhining ſcales of ſilver, almoſt like the white and glittering ſcales of ſome ſmall fiſh. There is, alſo, a way, by which I have brought diſſolv'd gold to ſettle about a body ſuſpended in its ſolution, in the form of a fine, and a high-colour'd calx of pure gold. But you may have an inſtance of ſilent precipitation, by rubbing a little, either of *Roman* or *Dantzic* vitriol, upon a newly whetted blade of a knife, moiſten'd with water; for the ſteel will thus immediately be overlaid with a reddiſh ſubſtance, which, by its colour, and other ſigns, appears to be manifeſtly cupreous. And 'tis not only out of ſolutions, made with acids, that bodies may be thus precipitated; for, upon ſearch, I have found, that there are, in nature, precipitants capable of ſilently precipitating ſome bodies, diſſolv'd in urinous, or other, not acid, menſtrua. It may, indeed, be juſtly ſuſpected, that ſuch precipitations are dangerous, by producing heterogeneous corpuſcles in the blood, that may prove too heavy, or groſs, to be evacuated. And I look upon this as a ſuſpicion to ſatisfy which 'twere fit to conſult experience; but, in the mean time, it may be repreſented,

1. That tho' ſome inconveniencies may happen from the bulk of the precipitated corpuſcles, yet this may be much inferior to the danger threatned by the over-active, and hoſtile particles, that produced, or fomented the diſeaſe.

2. That 'tis not neceſſary all concretions ſhould conſiſt of corpuſcles, too large to be thrown out at the maſs of blood; for, we ſee, that ſtony matter, which, as the chymical analyſis of it ſhews, is of a very compound nature, may be carry'd to all parts of the body. I knew a lady, who had a ſtone taken out of the lower part of her tongue. And phyſicians, who preſcribe large quantities of mineral waters, impregnated with iron, as I found thoſe of *Tunbridge* to be, and with ſulphur, ſuch as ſome of the *Bath* waters uſually are, build their expectations of a cure from them, upon a ſuppoſition that they are carried into the maſs of blood, and innermoſt parts of the body.

3. That yet precipitations may, poſſibly, be made of matter, contain'd in the blood, by medicines that do not get into the maſs of it. Phyſicians, ſometimes, give crude ſteel in ſubſtance, as well as prepared, to obtund the acidities of the blood, tho' the metalline corpuſcles, in

all probability, do not paſs into the maſs of that fluid, but are wrought upon by the matter, that, in its circulation, is thrown into the ſtomach and guts; which appear to be the ſeat of the operation of chalybeates, from the blackneſs they give to the excrements of the lower belly: but if they will have it, that prepared ſteel, for inſtance, calcin'd with ſulphur, paſſes thro' the pores of the inteſtines, or the fine lacteal veſſels, into the maſs of blood; 'twill be obvious to demand, why nature ſhould not be able to expel precipitated corpuſcles, at the ſame orifices, where ſuch compounded concretions as thoſe of ſulphur and that metal can enter.

4. That it may, with ſome appearance of reaſon, be ſaid, experience has already been conſulted about the expediency of employing precipitating medicines. For, not to urge that the learned *Sennertus* ſeems to intimate, that ſometimes the febrile matter may be precipitated out of the blood; *Kergerus* very ſolemnly declares, that, in the ſpace of fourteen years, he cured above a thouſand of fevers, without bleeding, purging, ſweating, &c. by a ſingle precipating remedy, and that univerſally, with all imaginable eaſe and ſafety. I endeavour'd, indeed, to obtain from *Germany* a confirmation of this matter of fact, but did not receive it; I find, however, that one of the emperor's phyſicians, declares himſelf inclin'd to believe it true.

But I can more eaſily ſuppoſe, that great, and deſireable changes may be wrought in the fluid parts of the body by appropriated precipitants, if it be true, as it is unanimouſly taught by a multitude of phyſicians, that many diſeaſes are cauſed by a putrefaction of the blood, and other animal fluids. For there is, in nature, a certain ſubſtance, or medicinal liquor, ſo powerful an enemy to putrefaction, that when a few grains, or drops of it, were put into a conſiderable quantity of water, that had been kept till it ſtunk as ſtrong, and offenſively, as carrion, (tho' it ſtill remain'd tranſparent) and diffuſed, by agitation, through it, precipitated therein a very ſmall and light feculency, which being remov'd, the remaining liquor was quite freed from all ill ſcent; nor did I obſerve, that the feculency it ſelf retain'd any. And, which is ſurprizing, all this was done in a very few minutes, by a very ſmall proportion of a precipitant, whoſe taſt was not at all either bitter, or acid, or urinous, or lixivious; which are circumſtances that may afford conſiderable hints to ſagacious inquirers.

PROP. IV.

The ſpecific may peculiarly ſtrengthen and cheriſh the heart; and, by that means, or otherwiſe, relieve the part affected.

This obſervation can ſcarce be made good, without entering into that important and perplexed controverſy, whether any medicines have a ſympathy with the head, heart, liver, &c. and, upon that account, de-

MEDICINE. deſerve the name of cephalic cordial, hepatic, *&c.* or to ſpeak more clearly, whether there be any medicines, that, in a peculiar manner, do good to this or that particular internal part of the body. In this diſpute the affirmative has been held, tho' I doubt upon ſlender grounds, in moſt of the phyſical ſchools, for ſeveral ages. But, in our times, many maintain the negative, and even deride the opinion they have forſaken. Some of them object, in a triumphant ſtile, that 'tis ridiculous to fancy ſuch a ſympathy betwixt a dead medicine and the parts of a living body; as if a phyſician could ſend a drug of an errand, to ſingle out a particular part among a multitude of others, and do it good offices.

But, notwithſtanding this, I think it very poſſible, that a medicine may ſo far reſpect a particular part, as tho' not to prove beneficial to that only, yet to be ſerviceable to it in a peculiar manner or degree: and this, I conceive, may happen upon one, or more, of the following accounts.

And, 1. when I conſider, that the firm parts of the body, as the heart, brain, liver, kidneys, *&c.* have each its particular ſtructure, wherein it differs from another; and probably the fluids alſo, as the blood, gall, lympha, *&c.* have their ſeveral textures; it ſeems probable to me, that the corpuſcles of a medicine, diſſolv'd in the ſtomach, and carry'd round by the liquors of the body, may, according to their determinate ſhape, ſize, ſtiffneſs, flexibility, motion, *&c.* be much more fit to lodge in one part of the body than the reſt, and, thereby aſſociating with its fibres, ſupply it with ſuch congruous particles as it either wants, or may prove beneficial to it, by re-eſtabliſhing or ſtrengthening its tone. And by this corroboration, the part may be enabled to reſiſt the hoſtilities of morbific matter, which phyſicians frequently obſerve to be thrown by the more vigorous parts upon ſuch as are weak or diſtempered; as is manifeſt in perſons ſubject to the gout, in whom peccant humours are very apt, upon ſeveral occaſions, to be tranſlated from the nobler parts; if thoſe be robuſt, upon the debilitated joints: on which ſcore, the gout, if it be well managed, is not, without reaſon, thought conducive to long life. Thus I knew a phyſician, who had ſuch a peculiar indiſpoſition in his jaw, that tho' he could uſe wines of ſeveral ſorts, without inconvenience, yet the drinking of a very little brandy, would ſoon give him the tooth-ach.

But I proceed to ſhew and illuſtrate, how the fitneſs of ſome medicinal corpuſcles, may enable them to aſſociate with thoſe of the part they are to affect. We ſee, from what happens in nutrition, eſpecially in that of ſucking children, that a ſingle aliment, as milk, affords, beſides various excrements, ſuch as the groſſer feces of the guts, and the more fluid ones of the bladder, the noſe, the cuticular pores, *&c.* a great number of corpuſcles that are detained and aſſimilated by parts of different ſtructures, as the brain, the heart, the bones, *&c.* ſince, otherwiſe, theſe parts could never be ſo plentifully nouriſhed by them, as daily to increaſe in all their dimenſions. And ſome parts, which in infants are cartilaginous, in proceſs of time become bony; a change not probably referable to the bare exiccation, by the native heat of the body, increaſing with age.

2. The friendly corpuſcles of a ſpecific medicine, may not only confirm the good ſtate of a determinate part, but greatly conduce to reſtore it to a ſound condition, when it is diſtemper'd; and this by two or three different means.

And, firſt, thoſe particles may diſpoſe the morbific matter to be more eaſily and ſafely expell'd; and that not barely as they may impregnate the whole maſs of blood, and ſo be carried by it, as well to many other parts, as to that we now conſider; but as their particular texture, motion, *&c.* may, in a peculiar manner, reſpect that particular modification, which the peccant matter acquires, by being produced or harboured in that determinate part. And that the particular ſtructure of an affected part, may very much diverſify the condition of a morbific matter, I argue from hence, that phyſicians declare, the petrifying matter bred in the kidneys of a perſon ſubject to the ſtone, to be reddiſh or yellowiſh; but when in the bladder, white, or of a light grey; and the ſtones generated in the former part, to be more friable, or of a ſlighter texture than thoſe that have their origin in the bladder; ſome of which are exceeding hard, eſpecially in compariſon of ſuch large ones as I have had out of the bladder, or gall, of luſty animals. The diſpoſition then, that the corpuſcles of the ſpecific may give the blood, or other liquor which conveys them, to act as an appropriated menſtruum, upon the peculiarly modify'd matter that obſtructs or diſaffects the liver, for inſtance, may enable the remedy to be very helpful to that part, by preparing the morbific matter for expulſion. But it may alſo aſſiſt the ſame part in another capacity.

For, ſecondly, it may ſo work upon the fibres, and ſtable portion of the part affected, as both to enable and excite it to get rid of its enemy; as by giving firmneſs and ſtrength to the fibres of the part, by contemperating, or correcting the immoderate heat, coldneſs, *&c.* thereof; by mortifying the acid, or other heterogeneous particles, that are lodged in the minute intervals of it, and, perhaps, even in the pores of its fibres; by allaying its convulſions, cramps, or other inordinare motions, that hinder it from performing its proper functions; and, laſtly, by relaxing or widening the pores, according to the exigency of the work to be performed. And, having thus prepared the matter to be expell'd, and diſpoſed the part to expel it, this may then alſo be excited to its office, by the ſame particles irritating the fibres, or motive organs, or ſtimulating them, to diſburden the matter that offends it. Thus a very ſmall doſe of cantharides, is known capable of making the bladder forcibly diſcharge it ſelf of urine; and often at the ſame time to

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And hence we may anſwer an objection, formerly mentioned againſt ſpecific medicines. For here we have a medicine, tho' a dangerous one, whoſe corpuſcles are ſo peculiarly adapted to the bladder, and urinary organs, that tho' when got into the maſs of blood, they are carried by it indiſcriminately to all parts of the body; yet often, without manifeſtly diſordering the reſt, they exceedingly affect and irritate the bladder alone. It may here be objected, that the firſt of our three ways, in which we ſay a particular part may be aſſiſted by a ſpecific, ſeems contrary to the ſecond; the former tending to corroborate, and the latter to relax and irritate it. But I anſwer, that ſince the part may be ſometimes in a natural, and ſometimes in a preter-natural ſtate; in the former a medicine will deſerve to be call'd appropriate, from keeping it ſound, which is moſt properly done by ſtrengthening it; and in the latter, merit the title of a ſpecific, becauſe it helps to reſtore it to a ſtate of ſoundneſs. And, again; tho' to effect this recovery, 'tis often very expedient, that the medicine procure an evacuation of ſome peccant matter, yet that evacuation is frequently much promoted and facilitated, by ſtrengthening the part, ſo as to enable it to diſburden it ſelf. And the ſame medicine may contain and communicate to the blood, corpuſcles of ſuch different ſhapes, ſizes, motions, *&c.* as ſucceſſively to relieve the part by both theſe means. Thus, phyſicians obſerve, that rhubarb not only purges the liver of choler, by its fine, laxative parts, but by its more earthy, aſtringent corpuſcles, ſtrengthens the tone of that part. I might add, that, in ſome caſes, this very corroboration of a diſtemper'd part may reſtore it to ſoundneſs; there being ſome diſeaſes of ſuch a nature, that they could not ſubſiſt in the affected part, unleſs thro' its debility, and the conſequences thereof, it were ſubject to admit, from time to time, freſh recruits of peccant matter to foment the diſorder. And, in ſuch diſtempers, if the ſtructure and tone of the part be re-eſtabliſhed by the operation of the ſpecific, its acquired vigour will enable it to reſiſt the entrance of new ſupplies of peccant matter, and to return them into the maſs of blood, to be thence diſcharged by the common ſhores of the body. In the mean time, nature will be able, by degrees, to ſubdue, diſſipate, or otherwiſe diſpoſe of that little portion of morbific matter that was lodg'd in the diſeaſed part.

We have not hitherto produced any example of the peculiar reſpect of a ſpecific, to a determinate, diſaffected part, apparently ſo incredible, as that a heavy, ſtony ſubſtance, being, in ſmall quantity, taken at the mouth, ſhould manifeſtly contribute to the cure of a broken bone, in the extreme parts of the body; yet, not to urge the teſtimony of chymical writers, I remember a *German* phyſician, who was famous for great cures, related wonders of that ſtone called *Oſteocolla*, eſpecially if improved by a ſkilful preparation, which he communicated to me.

But without preparation, the judicious *Hildanus* greatly commends it, upon his own obſervation, for very ſuddenly breeding a callus in fractures.

PROP. V.

A ſpecific may have its effect, by producing in the maſs of blood a diſpoſition to enable nature, by correcting, expelling, &c. *to ſurmount the cauſe of the diſeaſe.*

Whoever narrowly conſiders the practice of the moſt ſucceſsful modern phyſicians, will find that their preſcriptions are, in general, founded upon a ſuppoſition, that a great part of diſeaſes depend chiefly upon the vitiated conſtitution of the blood, and their cure upon reſtoring that fluid to a ſound ſtate.

Now this advantageous change of the blood may be effected by a ſpecific, ſeveral ways; and, particularly, firſt, by furniſhing the blood with ſome ſort of active corpuſcles, neceſſary to ferment it, or excite an uſeful commotion, or agitation therein. I do not here deſign to examine, whether the maſs of blood, contained within the veſſels of a living man, is capable of a ſtrict and proper fermentation; and therefore I have employed the word commotion, for ſuch as diſlike the other.

But as fermentation is become a general term, I ſhall not ſcruple to uſe it, after having premiſed, that becauſe many modern phyſicians, eſpecially ſince the learned Dr. *Willis*'s notions came to be in requeſt, have ſuppoſed fevers and agues to conſiſt in vitious fermentations of the blood; to diſtinguiſh the fermentation I here mean, from theirs, I call it uſeful.

Since, probably, then, there is often a vitious fermentation of the blood, there may alſo ſometimes be a want of fermentation, or a certain ſluggiſhneſs; upon whoſe account, either the brisk, inteſtine agitation, that fluid ought to have in healthful perſons, or a due quickneſs of circulation is wanting; upon which ſluggiſh ſtate of the blood, if it prove obſtinate and laſting, ſeveral diſtempers are uſually conſequent. There are, indeed, various medicines, ſuch as aromatics and ſpirituous liquors, diſtilled from fermented vegetables, ſometimes ſucceſsfully employed to correct this dull diſpoſition of the blood; but as theſe prove very hot, there will be ſeveral conſtitutions, and particular circumſtances wherein they may do more harm by their immoderate heat, than good by their ſpirituoſity. Beſides, the ſluggiſhneſs of the blood may ſometimes proceed from cauſes, that this ſort of hot medicines will not correct. I remember, that having moderately dry'd and powder'd a parcel of human blood, a vinous ſpirit totally inflammable, would not in many hours make a ſolution of it, or draw a red tincture from it; but a well rectified urinous ſpirit grew red upon it, in leſs than the tenth, or perhaps the twentieth part of that time.

A ſpecific medicine may, therefore, abound in corpuſcles of ſuch a nature, as, without dangerouſly heating the blood, to diſſolve thoſe particles that render it viſcid, ropy, or ſpiritleſs; and alſo, by enlivening the whole maſs, and putting it into a more briſk and kindly agitation, thereby fit it to throw off ſuch heterogeneous parts, or recrements, as were blended with it before; whence 'twill again freely paſs along the finer veſſels of the body.

That a ſpecific may perform this, will be more eaſily allowed, after conſidering that the generality of phyſicians acknowledge, there are ſeveral cordials, ſome of which they ſtile temperate, and others cold: and 'tis very poſſible, that the corpuſcles, which render the blood thick and ſluggiſh, may not be of a cold nature, but of a hot; and therefore may have their effects rather promoted than deſtroyed by hot remedies. Thus, as we formerly ſaid, if to the white of an egg you put a certain proportion of well rectified ſpirit of wine; inſtead of deſtroying the viſcoſity of the liquor, it will curdle a good part of it, and thereby produce a body far more remote from thinneſs and fluidity than it was before. And I remember I once made a ſluggiſh vegetable liquor, which preſently, by the addition of a little ſpirit of wine, became ſurprizingly viſcous and ropy.

2. Another means, whereby a ſpecific may befriend the maſs of blood is, by giving it the wanted dilatation or tenuity. This ſecond way, indeed, is of kin to the firſt, but different from it; becauſe in that the thing principally conſidered was, the fermentation or agitation of the blood; but this chiefly reſpects the conſiſtence of it; a particular of great importance to health: for if the blood be too thick, as often happens, it cannot paſs ſo freely and readily as it ought, thro' the capillary veſſels; which thence become gradually obſtructed, and the circulation retarded. And, on the other ſide, if the blood be too thin, and eſpecially if too vehemently agitated, 'tis apt to make its way out of the veſſels, and produce hemorrhages, or other bad effects, that uſually attend the extravaſation of the blood; which happening in ſo warm a place as a living human body, that fluid is very apt to putrefy, and thereby produce impoſtumes, and ſeveral dangerous ſymptoms.

Now a ſpecific medicine may remedy this faulty conſiſtence of the blood, by furniſhing it with corpuſcles, fitted by their figure, bulk, motion, *&c.* to diſable thoſe that make the blood groſs; or elſe to cut or divide the parts of the blood it ſelf, and ſo diſpoſe them to a greater fluidity. It may alſo produce in it ſuch pores, as will give admiſſion to the ſubtile etherial matter, that abounds in the atmoſphere, whereby the blood may be rarified. And, on the other hand, when the blood is too thin, as not only ſome diſeaſes, but ſome medicines too, eſpecially aloes, often make it; a ſpecific may reduce it to a good conſiſtence, either by furniſhing it with corpuſcles, apt to combine with the active ones, that did too much attenuate it before; or by helping nature to expel thoſe buſy particles by inſenſible tranſpiration, or ſome other eaſy way.

3. There is yet another manner wherein a ſpecific may conduce to rectify the ſtate of the blood; and that is by ſo working on the heart, as to make it advantageouſly regulate the tranſmiſſion of that fluid thro' it.

That a ſpecific may peculiarly befriend a particular part, and conſequently the heart, is granted by the generality of phyſicians, who think themſelves poſſeſſed of many cordials, as they call them; and we have already ſhewn it poſſible: 'tis, therefore, allowable to ſuppoſe, that the parts of a ſpecific may either diſſolve ſome particles they meet with in the heart, by which that noble viſcus is, by irritation, or otherwiſe, diſturbed in the regularity of its dilatations and contractions; or ſo corroborate the fibres, or moving organs of it, as to diſpoſe it to moderate the circulation of the blood that paſſes thro' it in the moſt advantageous manner. And that the diſpoſition of the heart, even when men have no ſenſe of it in the part it ſelf, may be of moment as to health and ſickneſs, appears credible; ſince a living human body, is not a mere lump of fleſh, bones, *&c.* but an exquiſitely well-contrived machine, whoſe parts are eaſily ſet on work by proper, tho' very minute agents; and by their action upon one another, perform far greater things, than can be expected from the bare energy of the agents that firſt put them into motion: whence, the diſpoſition of the heart being, tho' perhaps inſenſibly, changed, it may produce a remarkable alteration in the motions of the blood, and its paſſage thro' that part, in point of quantity, celerity, or both.

How much this change in the circulation may, in many caſes, conduce to ſickneſs or recovery, will partly appear by the effects of vehement, or durable paſſions of the mind. Thus 'tis obſerved, that in a deep ſorrow, which, in a manner, ſtraitens the paſſages of the heart, the blood is too ſparingly diſpenſed, and the enlivening ſpirits are not generated in ſufficient plenty. The blood is hereby, alſo, ſo diſpirited as, in theſe parts of *Europe*, to diſpoſe the body to the ſcurvy, which either produces or irritates ſeveral other diſeaſes. Thus, again, the paſſion of ſhame often ſuddenly alters the motion of the blood, and makes it ſwell the little veſſels that lie under the cuticula of the face, and ſometimes other parts. The like effect I have ſeen produced by a great and ſudden joy. And tho' its oppoſite paſſion, grief, has been uſually obſerved to deaden the appetite to meat; yet ſo much depends upon a regular tranſmiſſion of the blood, that joy has been found in ſeveral perſons, and I have known an eminent inſtance of it, very much to leſſen hunger: which effect M. *des Cartes* ingeniouſly attempts to account for, from the varied dilatation and motions of the heart. And it ſeems not abſurd, that the like motions may be cauſ'd by the corpuſcles of a ſpecific medicine, which, by affecting the fibres of the heart, after the manner of joy, may produce in it ſuch amicable dilatations

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In this manner, then, a ſpecific, by peculiarly affecting the heart, may greatly contribute to introduce, or re-eſtabliſh, a healthy craſis in the blood; which, being thus rectified and invigorated, may both befriend the body in general, and conduce to remove ſome particular diſeaſes, by ſtrengthening, and, perhaps too, exciting the particular part, in which the peccant matter reſides, to ſubdue or expel as much of it as it already harbours, and to reſiſt the acceſſion of more. And the blood being thus brought to a good ſtate, and the ſolid parts corroborated, the ſpecific that produces theſe effects, may be ſaid to cure ſome particular diſeaſes, which only continue by being frequently ſupply'd with vitious matter from the blood in its circulation.

PROP. VI.

A ſpecific remedy may unite its particles with thoſe of the peccant matter, and thereby conſtitute ſome different ſubſtance, to be eaſily thrown off, or ſafely continued in the body.

This I take to be one of the moſt proper and genuine methods of operation in ſpecific medicines; becauſe an effect is here produced, either without the aſſiſtance, or beyond the mere power of the manifeſt qualities of the remedy, and a cure, or relief, uſually obtain'd without violence, torture, or diſorder.

This manner of working in a ſpecific medicine, is of near affinity with one or two of thoſe formerly mention'd; but different from them in ſome particulars, as will appear hereafter. Sometimes, when a certain kind of acid has impregnated the blood, or lodg'd it ſelf in ſome ſolid part of the body, the corpuſcles of a ſpecific may, without any ſenſible conflict, be ſo qualified, as to make coalitions with the particles of the peccant acid; and, with them, conſtitute little concretions, which, differing from the minute parts of the acid, either in bulk, figure, ſolidity, ſtiffneſs, motion, or in two, or more of theſe, may become quite of another nature, and much more innocent than the acid it ſelf, before it was thus corrected. We are furniſhed with a notable illuſtration hereof, by digeſting *Aqua fortis* with an equal, or double weight of inflammable ſpirit; for, by this means, I found, that highly acid liquor ſo chang'd, as not to retain any ſenſible corroſiveneſs; and to exchange its piercing ſcent, and great acidity, for an inoffenſive, pleaſant ſmell, and a grateful, and actually ſweetiſh taſt. Which brings into my mind the practice of a preſident of the famous college at *London*, who, as himſelf told me, uſed to relieve a patient of very great quality, of nephritic torments, by giving her a large doſe of an inflammable ſpirit. But ſpirit of wine, by its effects upon ſeveral other acid menſtrua, wherewith I mix'd and digeſted it, appears not to work upon them uniformly, as they are all of them acids, but differently, according to the nature and proportion of the acid corpuſcles, with which the vinous ſpirits aſſociate.

And to ſhew, that this change and contemperation of the menſtruum, by the ſpirit of wine, is produc'd rather by a peculiar fitneſs of the convening corpuſcles of both, than by the contrariety that the vinous ſpirit has to the *Aqua fortis*, as an acid; I ſhall add, that pure ſpirit of wine, mix'd in a due proportion with highly rectified ſpirit of urine, will greatly abate its cauſtic property, and with it compoſe a ſalt much more moderate than the ſpirit; and which, being ſublimed, or rather reduced into a liquor, affords an excellent mixture, in ſome fevers and other diſeaſes as a medicine: and, with a ſmall skilful alteration, it is of great uſe in many chymical experiments as a menſtruum.

A few grains of the glaſs of antimony, made without addition, being taken inwardly, will vehemently both vomit and purge; and tho' wine, if well impregnated with its corpuſcles, proves a violent emetic and cathartic; yet if ſpirit of vinegar, that is, of degenerated wine, be, for a competent time, digeſted upon the glaſs finely powder'd, and when the liquor is ſufficiently impregnated with the particles thereof, abſtracted from it, there will thence ariſe a multitude of minute concretions, of which many grains may be given, without ordinarily provoking either vomit or ſtool. All mortifications, therefore, uſefully made by medicines, need not be of acids; ſince we here ſee, that acids themſelves may prove correctors: and, perhaps, it is by ſuch kind of combination, that ſome poiſons are ſubdued. I ſuſpect that it may as probably be upon this account, as upon any hitherto offered, that a man, ſtung with a ſcorpion, is cured by cruſhing the animal upon the hurt; as an acquaintance of mine told me he try'd upon himſelf; and a virtuoſo upon a ſoldier, with good ſucceſs. And, conſidering what a multitude and variety of figures, may fit ſuch particular corpuſcles to make coalitions, very different from both the component parts, it ſeems probable, that in a patient's body there may be made between the corpuſcles of the peccant matter, and thoſe of a medicine, ſuch uſeful combinations, as to produce concretions innocent or beneficial.

When a particle of peccant matter comes to be aſſociated with one of a ſpecific medicine, that combination may alter it for the better, not only by changing its magnitude and figure, but alſo by increaſing or leſſening its ſtiffneſs and ſolidity, and giving a new modification to its motion; as will eaſily appear from a little attention to the natural conſequences of the coalitions of bodies.

I might ſhew, *ex abundanti*, that the ſmall concretions made by the union of ſome morbific, with ſome medicinal corpuſcles, may not only become innocent, but ſometimes beneficial, by what happens to common ſublimate, from a farther preparation; for tho' this be a ſubſtance ſo highly corroſive and miſchievous, that a few grains of it will kill a man; yet by making a coaleſcence, with leſs than its weight of quickſilver, which is a body inſipid and ſcentleſs, the corroſive matter is thereby ſo alter'd and tamed, as to be turned into a kind of white, taſtleſs earth, call'd *Mercurius dulcis*; which, if ſkilfully prepared, and given in the quantity of many grains, is not only innocent, but a very good medicine; and that, perhaps, in more caſes than phyſicians are generally aware of.

And this may afford us a probable argument, to ſhew, that, notwithſtanding all the digeſtions and changes a ſpecific medicine undergoes in its paſſage thro' the body, it may ſtill prove ſalutary, when it arrives at the part it ſhould relieve. For, tho' the corpuſcles of the medicine ſhould be conſiderably chang'd by the way, yet 'tis poſſible they may, by that very alteration, be made medicinal; ſince they may thus be qualified, when they arrive at the part affected, to combine themſelves ſtrictly with ſome corpuſcles, whether morbific or others, that they find there; and with them compoſe new concretions, of a nature very friendly to the patient. Something analogous to this we may obſerve in aſparagus, which being eaten, affords ſtore of particles, that, mixing with thoſe they meet with in the kidneys, or the bladder, produce a new odour, very different both from that of mere urine, and from that of the plant. Thus, alſo, if good turpentine be taken by the mouth, 'tis known, that, arriving at the kidneys and bladder, it will mix its minute parts with thoſe it meets with there; whence emerge corpuſcles, that give the urine a very different ſcent, from that of either of the liquors; for it often has a fragrancy like violets.

Before I conclude this ſubject, it ſeems proper to take notice of a difficulty, that may, in general, be objected, to what has been hitherto deliver'd. It might be ſaid, that my arguments and explanations all along ſuppoſe the ſpecifics to be taken at the mouth; while 'tis known, that many external remedies are reckon'd among ſpecifics, which, perhaps, do but barely touch the body, as is the caſe in amulets, rings, *&c.* But, we may take notice, that the confidence with which many phyſicians reject, and ſome of them deride external ſpecifics, ſeems built upon this, that the medicine cannot get into the body; or, that in caſe it ſhould have ſome part of it ſubtile enough to gain admittance, that part muſt be too ſmall and inconſiderable, to produce any ſuch great change, as is neceſſary to the expulſion of peccant humours, and the conquering of a diſeaſe.

In anſwer to the former of theſe ſuſpicions; 'tis certain, that the human ſkin, tho' it ſeems an entire continued body, is really perforated with a great multitude, and, perhaps, variety of little outlets, which we call pores; many whereof are viſible by good microſcopes, even in the skin of dead animals; and others are manifeſtly inferr'd from the numerous little drops that cover the whole ſurface of it, at the firſt eruption of ſweat. And that theſe little perforations may prove inlets to the finer particles of medicines, externally apply'd, appears probable from ſeveral phenomena. Thus water will ſoak thro' the pores of a fine bladder, and diſſolve ſalt of tartar, or white ſugar, contain'd in it. And I have prepared a certain liquor, whoſe fumes, tho' not agitated by heat, would quickly penetrate ſeveral membranes of dead animals, and manifeſtly work on metalline bodies wrapt up in them. 'Tis a known thing, that quick-ſilver, outwardly applied in ointments, girdles, *&c.* will get in at the pores of the skin, and invade the internal parts of the body; and remain there longer, and, perhaps, operate more than the phyſician deſired. And, when once the effluvia of theſe external remedies have gained admittance at the cuticular pores, 'tis not difficult to conceive how they may proceed further: for underneath the cuticula, and cloſe to it, there are ſo great a multitude of capillary veſſels, that you can ſcarce thruſt a ſmall pin into any part, but the point will meet with and tear ſome of them; as appears by a ſmall drop of blood, that will iſſue out at the little orifice thus made. To which inſtance many others might be added, to ſhew the multitude, and branchings of the capillary veſſels, that lie immediately below the skin, and, for the moſt part, carry blood, tho' ſome of them may contain other juices, and diſcharge their recrements by ſweat, or inſenſible tranſpiration. Now, theſe fine capillary veſſels, having their cavities immediately continued with larger, and, by their means, with greater ſtill, which are branches of the largeſt of all, the corpuſcles of the medicine, once got into the capillary, may have an eaſy paſſage into the branches of the principal veins; and ſo, by virtue of the circulation, come to be quickly mingled with the maſs of blood, and thence conveyed to all the parts of the body. Thus it has been often obſerved, that arſenical amulets, worn upon the breaſt, tho' they ſcarce touched the skin of that part, produced terrible diſorders in the heart, and ſeveral dangerous ſymptoms in other parts of the body. And, 'tis recorded by credible authors, that cantharides, tho' only held in the hand, or carried in the pocket, have tranſmitted their effluvia as far as the bladder, and there occaſioned great pain, and other pernicious effects.

To the ſecond objection againſt ſpecific remedies, that if their effluvia could get entrance into the body, theſe are not efficacious enough to have any conſiderable effect upon any internal diſeaſe; I obſerve, firſt, that the number of the corpuſcles which paſs from the outward medicine into the body, may be far greater, and, therefore, more conſiderable, than moſt men are apt to think. This may be render'd probable, by the great multitudes of odorous, and, conſequently, ſenſible expirations, that are continually emitted, for a very long time together, by ambergreaſe, musk, civet, and much more by skilful compoſitions of them. And, that alſo ſubtile effluvia, even without the aſſiſtance of heat, may quickly penetrate membranes ſo plentifully, as to act on ſolid bodies contained therein, I have experimentally ſeen, and made appear to others.

Secondly, that the corpuſcles of a medicine may retain their nature and power of operation, notwithſtanding their being ſtrained thro' the skin. For mercury is often found in the form of quick-ſilver, in the dead bodies of ſome men, who had been frequently anointed with mercurial unguents. And, by this means, a patient may be as violently ſalivated, as if he had ſwallowed mercurial medicines. Thus I have frequently obſerved, that a little opium, mixed up with other ingredients for a plaiſter, would, by outward application, take off the acute pains of remoter internal parts.

And, laſtly, that the corpuſcles of a ſpecific may, on ſeveral occaſions, act more powerfully, by getting in at the pores of the skin, than if the remedy had been taken at the mouth; becauſe its particles might, in the latter way, be divided, or greatly alter'd, by the ferment of the ſtomach, by their filtration in the inteſtines, and their long and winding paſſage thro' them and the lymphaducts, before they arrive at the heart, to be mingled with the blood; whilſt the corpuſcles of an external ſpecific, preſently after they are paſt the skin, get into the contiguous capillaries, and thence preſently paſs into the fluids, unalter'd. Whence it appears, that thoſe phyſicians are much miſtaken, who think a topical medicine can, at beſt, only relieve the part it is apply'd to.

And, what is more extraordinary, bodies, outwardly apply'd, may prove ſpecifics for ſome diſeaſes, for which, by the bare knowledge of their effects, when taken in at the mouth, they might ſeem not ſuited. Thus camphire ſwallowed, is, in the doſe of a very few grains, a great heater of the blood; and, in ſome countries, extoll'd by phyſicians in particular kinds of ill-conditioned fevers; yet it is outwardly apply'd to take off thoſe redneſſes of the face, that are thought to proceed from a heat of blood, and uſed in ointments againſt burns. Thus, ſpirit of wine, which tho' ſo hot when drunk, is a very good remedy in burns; eſpecially if the part be early moiſtned therewith. Bread, that is counted ſo moderate and well-temper'd an aliment when eaten, has, if chew'd and outwardly apply'd, conſiderable virtues in ſeveral external diſorders. And I know an ancient and experienced phyſician, who uſes to purge ſuch children as will not eaſily be brought to ſwallow medicines, by applying ſomething to their navels, that does not offend them by its colour, ſmell, or griping. And this himſelf, more than once, confeſs'd to me, is but an ordinary aliment, which moſt men, and I among others, have frequently taken, unprepar'd.

'Twere eaſy to mention a great many external ſpecifics, from the writings of phyſicians; but I purpoſely forbear it, becauſe, to ſpeak freely, I ſuſpect that moſt of thoſe remedies, tho' greatly extoll'd, have been but little examined by the perſons who deliver them. And it

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it may ſuffice for my preſent purpoſe, to alledge a few inſtances, that have been recommended to me either by my own experience, or that of ſome friends.

I lived in the ſame houſe with a learned and judicious perſon, who, being ſubject to paralytic fits, and to be frequently tortur'd by violent cramps, was uſually, on a ſudden, relieved, by wearing, or handling the tooth of a true hippopotamus, or river-horſe. And he affirmed to me, that upon leaving off the uſe of it for any conſiderable time, either out of curioſity, or to ſatisfy ſome friend, the fits would return, with violence, upon him. I remember alſo, that having my ſelf been, for ſome years, frequently ſubject to cramps, and complaining of it to a phyſician who had travelled into cold countries; he told me, that he had brought home with him ſome rings, made of the true elk's hoof, from a place where thoſe animals are uſually employ'd; and that with theſe he had cured many of the cramp: one of them he preſented me to make trial with; which I the more willingly accepted, becauſe he aſſured me, that ſeveral of them, ſold for genuine, were either counterfeit, or of no efficacy. And, tho' I did not find, that if the cramp ſeized me in the calf of the leg, the ring would much relieve me; yet when the fits were but moderate, and in other parts, eſpecially the hands, I found my ſelf eas'd ſo often, and ſo ſuddenly, that I was at firſt ſurprized at it; and uſed to have the remedy laid, every night, by my bed-ſide, to be ready upon occaſion. And what ſeemed ſtrange, I ſeveral times found, when the cramp ſeized my foot, or my toes, the pain was quickly removed, tho' I only apply'd the ring to my finger.

An eminent phyſician, diſcourſing with me concerning a patient of his, that was ſubject to a nocturnal *Incontinentia urinæ*; I told him of an empyrical remedy, and which, at leaſt, ſeemed ſafe, tho' it ſhould not prove effectual; and it was only a ſimple animal ſubſtance, to be worn in a ſarſenet bag, next the skin; for which the phyſician long afterwards gave me thanks, and told me, he was ſurprized at the effect thereof; but that he obſerved, when the patient had worn it, till probably the virtue began to decay, that is, till its effluvia were almoſt ſpent, he found occaſion for a freſh remedy.

I do not affirm that theſe appenſa, any more than other remedies, will always ſucceed; and I think one may aſſign ſome probable reaſons for the want of uniformity in their effects. But for my preſent argument it ſuffices, that they ſometimes ſucceed; ſince that is enough to ſhew it poſſible, that outward medicines may operate upon inward diſtempers.

A young lady was cured of a large tumour in her neck, ſuppos'd to be ſcrophulous, by barely applying to it the hand of a man, who died of a lingering diſeaſe, till ſhe felt the coldneſs thereof penetrate to the innermoſt parts of the ſwelling; the operation being repeated more than once whilſt the corps continued ſweet. This method was adviſed by one of the moſt candid and ſkilful phyſicians of the *London* college, who gave me this relation, and ſhewed me a very noble preſent, which he received for his advice. This remedy is mentioned by *Helmont*, and long before him, by *Pliny*; tho' its virtue generally ſeem'd to have been disbelieved, or forgotten, till *Franciſcus Ulmus* took notice of a caſe very like the preſent; affirming, that by this remedy alone, after others had been fruitleſly employed, he knew a noble virgin to have been perfectly cured.

I was, one ſummer, obnoxious to frequent bleedings at the noſe, for which I ſometimes uſed one remedy, and ſometimes another; and, for the moſt part, with good, tho' not with ſudden ſucceſs. But falling once into a fit, the violence whereof alarm'd me, I reſolved to try an unuſual remedy, the true moſs of a dead man's ſkull; which had been ſent as a preſent out of *Ireland*, where it is more eſteemed than elſewhere: this remedy I did not employ in the uſual manner, by putting it up my noſtrils; but, notwithſtanding the briskneſs of my hemorrhage, try'd, whether the medicine would produce its effect by being only held in my hand; by which means I found, to the ſurprize of the by-ſtanders, that the blood ſpeedily ſtopp'd: nor have I been troubled with it ſince that time. But this is far leſs ſtrange, than what was affirmed to have happened to one of the moſt eminent members of the royal ſociety; who, being of a very ſanguine complexion, found himſelf ſo violently affected by the moſs of a human skull, that ſometimes, when he was let blood, if, for curioſity ſake, he held a quantity of this moſs in his hand, the blood would ceaſe running till he laid it aſide. This was not only ſolemnly averr'd to me by himſelf, but confirmed by his ingenious phyſician, with both whom I had a particular acquaintance; otherwiſe I ſhould have thought the thing ſcarce credible, unleſs imagination, a faculty very ſtrong in that gentleman, contributed to the ſtrange effect of the remedy.

The external ſpecifics hitherto mentioned, are afforded by vegetables and animals; which, being bodies of a ſlight texture, may be ſuppoſed to have their parts more volatile; I ſhall, therefore, produce two or three examples from the mineral kingdom; the ſubjects whereof are generally thought indiſpoſed to emit effluvia.

I knew a phyſician, who enjoyed a good ſtate of health, except that after a few hours ſleep, he waked in the night with great terrors, followed, for a long time, by violent and frightful palpitations of the heart. To remove this diſorder, he try'd all that his art ſuggeſted, but without ſucceſs: happening afterwards to mention his caſe in a company of merchants; one of them told him, he might eaſily find relief, from a remedy that had been found efficacious, both upon himſelf and others. This he ſaid was to take flat and ſmooth cornelian ſtones, ſuch as they bring for rings from the *Eaſt-Indies*, and to ſew eight or ten of them to a piece of ſcarlet cloth, or flanel, to be hung about his neck; ſo that they immediately touch the skin over againſt the

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the heart and mouth of the ſtomach. Theſe the phyſician procured, and, in no long time after, receiv'd great benefit therefrom; ſo that he, at length, thought, he might ſecurely leave off the uſe of theſe ſtones, which he did once or twice; but finding the diſtemper to return each time, within a very few weeks after ſuch a diſuſe; he reſolv'd to keep them always on; as he had long ſucceſsfully done, when he told me this ſtory. And to convince me of the reality hereof, he preſented me with ſome of the like cornelians. But having not yet had an opportunity to make uſe of them, I ſhall not conclude that the remedy will always ſucceed; but that 'tis, at leaſt, poſſible ſuch an external remedy may be very effectual.

I ſuſpect that thoſe, who firſt made uſe of this remedy, had the hint from what *Galen* ſays of the jaſper; a ſtone, wherein we obſerve various colours; I my ſelf having ſeen mixtures of red therein, almoſt as deep as that of cornelians. Of this ſtone, *Galen* relates, that rings were ſometimes made, with a fiery dragon engraven thereon, and recommended as very friendly to the ſtomach, being apply'd to the mouth of it. And tho', with ſafety, he omitted the ſculpture, he yet approves of the ſtones, upon his own frequent experience, wherein he apply'd them, almoſt in the manner of our cornelians.

I lately mention'd the efficacy of a cramp-ring, upon the *Genus nervoſum*, but it ſeems more ſtrange, that a ſtone-ring, worn on the finger, ſhall be able to affect the maſs of blood, and particularly that deprav'd portion of it, which nature ſends to the hemorrhoidal veins; yet the experienced *Monardes*, having deſcrib'd the blood-ſtone, that is brought from *New-Spain*, and repreſented it as a jaſper, not only commends it againſt hemorrhages, when apply'd to the bleeding part, but adds, "that he has ſeen ſome cured of the hemorrhoidal flux, by "conſtantly wearing upon their finger, rings made of this ſtone"; and the ſame he declares of the menſtrual flux. That ſome kinds of the *Lapis Nephriticus* are of great virtue, we have the teſtimony of the judicious *Boetius*, and the learned *Johannes de Laet*, whoſe praiſes of it are confirm'd by *Monardes* and others. But no author, that I have met with, ſpeaks more home to our purpoſe, than a conſiderable merchant of *Leipſic*, whoſe extraordinary obſervations are recorded by the very learned *Untzerus*, who, among other remarkable particulars, declares, the merchant affirm'd to him, that by wearing this ſtone, for ſome days, in a nephretic caſe, the calculous matter was ſo powerfully thrown off, that a multitude of ſmall grains of ſand were expell'd at the corners of his eyes. And the like effect he had often obſerv'd of that remedy in ſeveral other perſons. The merchant adds, that by wearing the ſame ſtone, his wife, who was troubled with a great catarrh, found it conſiderable cathartic; ſo that, the firſt day, ſhe was thereby purg'd fourteen or fifteen times; the next, nine or ten times; and afterwards, had her body kept very open by its means: and that he found this ſtone operate as a purge, tho' not ſo ſtrongly, upon himſelf.

Thus then, from a bare conſideration of the ſubject, have I ſhewn ſome of the principal ways, by which, I conceive, ſpecific medicines may cure diſeaſes, or, at leaſt, much leſſen them. But I am far from denying, that there may be many others, whereby the ſame effects may be produced.

And, as I did not pretend, that a ſpecific medicine, or nature, by means thereof, commonly effects a cure by any one of the particular ways propos'd, excluſive of the reſt; but rather think, that two or more of them may ſometimes concur to the effect; ſo neither did I propoſe to explain their particular ways of working; but only to ſhew them in general. Nor do I, laſtly, aſſert, that the means I have pitch'd upon are the true and genuine ones, by which the medicine acts, but propoſe a poſſible one, by which it may act; ſo that I only offer my explanations, as poſſible, or not improbable; which is ſufficient to anſwer my deſign in proving the notion of ſpecific remedies, agreeable to mechanical philoſophy.

SECT. II.

The uſe of ſimple medicines recommended.

SINCE ſpecific medicines muſt, to deſerve that name, be very efficacious, yet are, for the moſt part, either ſimple, or very little compounded; what we have deliver'd concerning them, affords me a proper occaſion to invite the faculty of phyſic, to the uſe of ſuch remedies, as are either ſimple; or, when compoſitions are neceſſary, to employ no more ingredients than are abſolutely neceſſary to anſwer the indications.

This ſort of ſimple, or lightly compounded remedies, I am induced to prefer to thoſe crowded compoſitions, wherein men ſeem to have aimed at conquering diſeaſes by the multitude of their ingredients; and this for ſeveral reaſons. But, before I produce them, I deſire the advantages, here aſcrib'd to ſimple medicines over others, may be underſtood not in an abſolute, and indefinite ſenſe, but *Cæteris paribus*.

From the advantage of foreſeeing their effects.

Firſt, then, it is much eaſier to foreſee the operation of a ſimple, than of a very compounded medicine; ſo that phyſicians may proceed more ſecurely in employing the former than the latter. And, indeed, if I do not greatly miſtake, we often preſume too much upon our own abilities, in ſuppoſing we know before-hand what will be the qualities and effects of a mixture of many ingredients of different natures; ſince ſeveral bodies, by compoſition, and the change of texture conſequent thereon, receive great and unexpected alterations. Several manifeſt inſtances of this truth, may be met with in colours, where what is produced by the mixture of bodies, appears quite different from that of any of the ingredients employ'd. As when a blue ſolution of copper, made in ſpirit of urine, produces with ſyrup of violets, which is alſo blue, a fair green.

Thus, alſo, having put together ſome tincture of iron, made with good ſpirit of vinegar, and a volatile tincture of ſulphur; from a confuſion of theſe, two very red liquors, there immediately aroſe a very dark, and almoſt inky mixture, that retained no redneſs at all.

The like remarkable changes I have ſeveral times produced, by mixtures, in ſeveral other qualities of bodies, beſides their colour, as in their odours, taſts, *&c.* And why ſuch alterations may not be alſo effected by compoſition in ſome medicinal qualities of bodies, I cannot ſee. Quick-ſilver, inwardly taken, uſually cauſes either no evacuation, or one at the mouth; but if diſſolved in ſpirit of nitre, and precipitated with ſea-ſalt, it yields a white precipitate; which being edulcorated, and warily given in a juſt doſe, ſeldom fails to work, not by ſalivation, but by ſtool. On the other hand, glaſs of antimony, whereof a very few grains, given in ſubſtance, prove violently cathartic and emetic; yet, being diſſolved in ſpirit of vinegar, will not uſually either vomit or purge; tho' the menſtruum be drawn from it, and the glaſs given in a larger doſe than when pure and unmixed.

And tho' by fluxing crude antimony with nitre and tartar, as in the ordinary way of making *Crocus metallorum*, there is produced a medicine ſo very emetic and cathartic, that an ounce, or leſs, of the wine, wherein it has been infuſed, tho' without ſenſibly loſing its weight, will operate ſtrongly, both upwards and downwards. Yet I have known ſome perſons, who would, without ſcruple, take ſeveral grains of crude antimony, in ſubſtance; and one particularly, who long continued the uſe of it, without being vomited, or purged thereby. And trials, purpoſely made, have informed me, that if, inſtead of ſalt-petre and tartar, antimony be prepared with well dry'd ſea-ſalt, and a little ſalt of tartar, tho' both theſe amount not to above half the weight of the nitre and tartar vulgarly uſed; yet the antimony well fluxed with theſe for about an hour, is thereby ſo altered and corrected, as to afford an uſeful medicine; of which may be given from twelve grains to half a dram, or more, in ſubſtance, without ordinarily working either by vomit or ſtool, but uſually by ſweat, and ſometimes by urine. Whence we ſee, that antimony may be either made a more dangerous or a more friendly medicine, than it is of it ſelf, according to the ingredients wherewith 'tis aſſociated; tho' theſe be in themſelves innocent, and, perhaps, of kin to one another. And even chymiſts, as well as other preſcribers of remedies, ſometimes add to a ſimple, ſuch things as rather deprave, than improve it. Thus one of their great patrons complains, that flower of ſulphur, by being ſublimed from calcined vitriol, *&c.* under pretence of purifying and ſubtilizing it, really acquires a hurtful corroſiveneſs.

Their being more ſafe.

2. Another advantage of ſimple medicines is, that, *cæteris paribus*, they are more ſafe than compounds, eſpecially if the patient be valetudinary.

tudinary. 'Tis too frequent, both in herbariſts and other writers on the *Materia medica*, to give us rather encomiums, than impartial accounts, of the ſimples they treat of. Thus they enumerate and magnify all the virtues they have, and ſometimes more than they have; without taking notice of their ill qualities; upon whoſe account, nevertheleſs, they may be inconvenient, hurtful, and dangerous to ſome conſtitutions: as, in particular caſes, ſeveral perfumes, tho' very grateful and refreſhing to moſt men, are yet very hurtful to many women, and eſpecially to the hyſterical. I have known the ſmell of musk greatly diſorder an eminent perſon, tho' otherwiſe of a robuſt conſtitution. I have alſo known ſeveral perſons of both ſexes, very much offended by the ſcent of roſes. Wormwood, tho' for many purpoſes an excellent plant, has been ſo often found to diſaffect the head and eyes, that I have, for ſome years, forbore it my ſelf, for fear of the head-ach, and forewarn'd others of it whoſe eyes are weak. I am acquainted with a very learned phyſician, who, tho' he has naturally very good eyes, found, upon an obſtinate trial, that the plentiful uſe of wormwood, in wine and beer, ſo greatly decayed his ſight by degrees, that at length he could not read a gazette without ſpectacles; but by barely leaving off the uſe of that plant, he quickly recover'd the vigour of his eyes. This relation I had from himſelf, ſoon after the thing happened.

And I queſtion not that we might find, upon ſtrict enquiry into the nature of ſimples and medicines, many that have bad qualities, unobſerved by phyſical authors. I have more than once foretold ſome hurt that patients would receive, by the uſe of applauded medicines, preſcribed them by conſiderable men; when, upon their authority, my warnings were neglected, and the uſe of the remedies unhappily perſiſted in. I once ſaw in the hands of a learned traveller, an *Arabic* manuſcript, about the *Materia medica*, the method whereof ſeemed more accurate than any thing I had met with on that ſubject. For the author had been ſo wary, that, after the columns wherein he taught the virtues, doſes, *&c.* of every drug, he had a diſtinct one for its bad qualities, with the conſtitutions and diſeaſes, wherein the uſe of it might be dangerous or inconvenient. I think it, therefore, reaſonable to ſuſpect, that, where a great many ingredients are blended into a ſingle medicine, one or other of them may have different operations from thoſe deſigned by the phyſician; and, by awakening ſome ſleeping ferment, produce a new diſtemper, or excite and actuate ſome other hoſtile matter, that lay quiet before, and which would have been gradually ſubdued by nature, had it not been unſeaſonably rouzed, and aſſiſted by ſome ingredient, that, perhaps, was, without any reaſon, added to the medicine. I have had ſo many unwelcome proofs of this in my ſelf, that it engages me the more, to caution others againſt the like inconvenience.

3. Another

MEDICINE.

Commodious for exhibition.

3. Another benefit accruing from the uſe of ſimple medicines, is, that thereby the patient may, without burdening his ſtomach, or nauſeating the remedy, take a larger doſe thereof, or of that ingredient, wherein the virtue chiefly reſides. Phyſicians are often obliged to ſtint themſelves in the doſe of a medicine, for fear of diſguſting the patient, or oppreſſing his ſtomach. Now when there are many things heap'd together in a moderate doſe of a compounded medicine, the ſuperfluous, or leſs efficacious ingredients, muſt neceſſarily take up a conſiderable part of that determinate doſe; and, conſequently, leave proportionably leſs of the more appropriated, or uſeful ingredients therein.

To ſay, that all the ingredients crowded into a great compoſition, are proper, and conduce to the ſame purpoſe, is, I doubt, not always true.

If a baker, to make the beſt bread he can, for a perſon of a weak ſtomach, ſhould, to wheat flower, add the meal of rye, barley, and oats; tho' all theſe ingredients be good and nouriſhing, and each of them uſed to make bread, yet no body would take him for a skilful baker; and but few prefer this compounded bread, to that more ſimple ſort made of wheat alone. So to make good gun-powder, a skilful man would not, to ſalt-petre, brimſtone, and charcoal, add wax, roſin, and camphire; tho' theſe are very inflammable ſubſtances as well as ſulphur. And thus to prepare a cordial-water, whereof a ſmall quantity were to be given to a fainting perſon, you would not, with ſpirit of wine, or brandy, mix mead, cyder, *&c.* tho' each of theſe be a ſpirituous liquor.

Gum arabic is preſcribed in ſeveral compoſitions, as proper to mitigate the ſharpneſs of urine; but, by reaſon of the quantity of the other ingredients, wherewith 'tis uſually mix'd and clogg'd, no more than a ſmall proportion of it comes to a doſe; wherefore, leaving out all other things, I have given a dram, or more of it, at once, in powder, mix'd with ſome convenient vehicle, and found very conſiderable effects from it. And I remember, that a gentleman of great note, coming to bid me farewel before he entred upon a troubleſome journey, to ſome mineral waters, for a very painful ſharpneſs of urine; I knowing the caſe to be neither venereal, nor from the ſtone in the bladder, deſired him, before he went, to make uſe of this powder'd gum, once or twice a day; by which means he thought himſelf quite cured, and forbore proſecuting his journey, not only for that year, but the next. Againſt the chin-cough in children, which often fruſtrates the endeavours of phyſicians, I have not known any magiſterial compoſition ſo effectual, as the ſimple juice of penny-royal, a little ſweetned with ſugar-candy; and given from time to time in the quantity of a child's ſpoonful. There are many and obvious examples of the great efficacy of ſo ſimple a remedy as aſſes milk, which yet, in ſome caſes, I think inferior to that of goats, if taken in a ſufficient quantity, and for a competent time. There are alſo many inſtances of dangerous and ſtubborn diſeaſes, that have been cured by common cows milk, when drunk very plentifully, and for a long time together. Perhaps, it is no leſs remarkable, that in a few days time, diarrheas and dyſenteries are happily and eaſily cured, as I have ſometimes known them, by the bare uſe of ſo ſlight a remedy as milk, wherein, whilſt it is gently boiling, an equal quantity of fair water is added, little by little, till at laſt there remains but as much liquor, as the milk alone amounted to at firſt. This ſimple alimental medicine, being freely uſed for common drink, has been very frequently found to cure different kinds of fluxes, even in *Ireland*, where they are endemical. I have formerly recommended *Paronychia foliis rutaceis*, againſt that ſtubborn diſeaſe, the king's-evil; but muſt not here omit a notable confirmation of the utility of an alterative ſimple, given in a conſiderable quantity. A phyſician whom I knew, was ſent for to a ſcrophulous patient, in whoſe throat he found a tumour ſo large, and ſo unluckily ſeated, that greatly compreſſing the œſophagus, it render'd deglutition exceeding difficult; the tumour was likewiſe ſo hard and ſtubborn, as not to be diſcuſs'd, nor brought to ſuppuration; whence the patient was put in imminent danger of being ſtarv'd. In this ſtrait, the phyſician remembring the character I had given of whitlow-graſs, ſent about the country to get all that could be procured; and at firſt gave a little of it, in the form of infuſion, in ſuch liquid aliments as the patient was able, tho' with great difficulty, to get down: and having, by this means, after ſome time, gradually made the deglutition more eaſy, he gave the remedy in greater plenty, to imbue the whole maſs of blood, and juices of the body, with the virtue of the herb; whereby the tumour was at length diſſolved, and the patient ſecured.

And tho' I might here enumerate the virtues of ſome other ſimple remedies, plentifully given, I ſhall rather obſerve, in general, that ſeveral alterative ſimples would, doubtleſs, be found far more effectual than is commonly thought, if they were given in a very large doſe, and continued for a competent time. And, probably, many phyſicians would not be ſo forward, as they are, to reject either ſpecific or ſimple remedies, if they allow'd them as fair a trial as their own preſcriptions; ſuch as the officinal chalybeates, the *Spaw* or *Tunbridge* waters, the decoctions of guaiacum, *&c.* which they often give, with many intermediate helps, for a month, or ſix weeks, or ſometimes two months together, without expecting they ſhould perform the cure in a few days time.

Eaſily procurable.

4. The fourth conſideration, that recommends the uſe of ſimple medicines, is, that, *cæteris paribus*, they are more eaſily procured than compounds. This aſſertion needs little proof. And, where ſeveral ſimples are required, one or more of them may often prove difficult to be got; and all of them will ſtill be troubleſome to form into a

compoſition. How uſeful the knowledge of parable remedies is, I need not here endeavour to prove; but ſhall add, that ſome medicines are eaſily obtained, without reſorting to the ſhops of apothecaries; ſince thoſe of artificers are often furniſh'd with them. Thus among maſons, and bricklayers, we commonly meet with quick-lime, whoſe bare infuſion, in common water, is, of it ſelf, an excellent medicine in ſeveral caſes; and, as experience has taught me, may be made the baſis of ſeveral good remedies, both external and internal: among the latter of which, may be reckon'd an ointment, that I uſually keep by me, againſt burns, made only by beating up ſtrong lime water, with as much good linſeed oil, as can be made throughly to incorporate with it into a white unguent.

The linſeed oil, which is to be had in the ſhops of varniſhers and painters, exhibited, alone, in a large doſe, as that of ſeveral ounces at a time, I have known prove very ſerviceable in breaking pleuritical empyema's. Simple oil of turpentine alſo, that may be uſually had in the ſame ſhops, is a noble remedy in many diſeaſes. And I have receiv'd great thanks, both from phyſicians and chirurgeons, for recommending the uſe of it to them in wounds; and, particularly, where one would expect little from it, in the ſtanching of blood, if it be ſeaſonably apply'd very hot to the wounded parts; whilſt it alſo greatly promotes a good digeſtion. A chirurgeon to a great monarch, and one of the moſt skilful men I ever met with of his profeſſion, confeſs'd to me, that in an admir'd cure, which he perform'd of a deſperate gangrene, in an eminent perſon, very aged, and almoſt bed-rid, the medicine he aſcrib'd moſt to, was the oil we were ſpeaking of. And becauſe he, and others, frequently uſe ſpirit of wine, with good ſucceſs, in gangrenes, which being ſuppos'd incapable of mixing with oil of turpentine, I thought it might prove of ſervice to practitioners, to be able to make a mixture of the two, that might, probably, be more penetrant than the one, and leſs fugitive than the other. Such a mixture I eaſily made, by digeſting, for a while, and ſtrongly ſhaking, from time to time, about equal parts of good oil of turpentine, and throughly dephlegm'd ſpirit of wine, till by imbibing, or diſſolving, great ſtore of the oleaginous parts, the liquor obtain'd a yellow colour; for which reaſon I call it the tincture of oil of turpentine.

There is another ſimple, to be found in the ſhops of colour-ſellers, which, tho' very offenſive to the taſt, and ſomewhat diſagreeable to the ſtomach, hath a very great anti-nephritic virtue. I procured it with difficulty, from a very extraordinary chymiſt, who, tho' a ſparing commender of remedies, extoll'd this, as the beſt he ever met with to cure the ſtone, where it was not too big to paſs, and to prevent the increaſe of it where it was. I have alſo known it us'd glyſter-wiſe, with very good ſucceſs, in a fit of that diſeaſe; but inwardly, I had no occaſion to try it, except upon my ſelf: and judging it innocent, as indeed I found it rather anodyne than forcing; I took it, now and then, mix'd with oil of ſweet almonds, to allay the taſt, as a preſervative from the gravel; for which purpoſe, I thought it more manifeſtly effectual, by leſſening either the bulk of the grains, or the quantity of the ſand, or both, than any of the remedies I had uſed, with the ſame view, for ſeveral years before; yet I ſcarce took a quarter of the doſe, preſcrib'd by the perſon who communicated the medicine to me. His order was, to take, from time to time, either by it ſelf, or in ſome convenient vehicle, two or three ounces of the ſtale expreſs'd oil of walnuts.

Before I leave the ſhops of tradeſmen, I ſhall take notice of one medicine more, that ſeems to have been firſt lodg'd there, and from thence tranſlated into the ſhops of apothecaries. The medicine, I mean, is *Caſtile* or *Venetian* ſoap; which being a body, abounding with alkaline ſalts, and oleaginous parts well combined, invited me to make ſome experiments with it, as a ſubſtance applicable to phyſical uſes. As to its medicinal virtues, 'tis prevalent againſt the jaundice; for which purpoſe, as I have been inform'd, 'tis in great requeſt among ſome skilful men in *Holland*; and experience has recommended it to me againſt the ſtone: but that for which I chiefly prize it, is its virtue in caſe of making bloody urine. A conſiderable merchant of *Cork*, in *Ireland*, being afflicted with this diſtemper, in ſo violent a degree, as to be thereby unqualified for his buſineſs; I adviſed him to ſcrape as much *Caſtile* ſoap into a ſpoon, as it would conveniently hold, without being preſs'd, that is, near a dram in weight; and having fill'd the vacant part, with ſome convenient vehicle, to ſwallow it, and waſh it down with a large draught of the ſame liquor; repeating the doſe twice or thrice a day, if need required. The manifeſt relief he found, by this ſeemingly deſpicable medicine, within two or three days, invited him to continue the uſe of it a while longer; by which means he has now, for ſome years together, liv'd quite free from his diſtemper, without ſcrupling to ride on horſeback as his occaſions require. This gentleman farther told me, he had adviſed the ſame remedy to ſeveral others in the like caſe, who were, likewiſe, happily cured by the uſe of it.

And likely to improve the knowledge of the Materia Medica.

5. The laſt, and principal reaſon, that induces me to wiſh phyſicians would employ ſimple remedies, as much as poſſible, is its being one of the likelieſt ways, and, perhaps, abſolutely neceſſary, to promote the practical knowledge of the *Materia Medica*; for, whilſt a multitude of ingredients are crowded, or confounded, in one receipt, 'tis almoſt impoſſible to know, with any certainty, to which of the ſimples the good or bad effect of the remedy is to be aſcrib'd; or whether it be not produc'd by a power, reſulting from the particular qualities of them all, united under one temperament, and acting, conjointly, as a whole. So that by this method, of jumbling ſimples into compounds, I ſee not how, in many ages, men will be able to diſcover the true qualities of the particular bodies, compriz'd in the *Materia Medica*.

On the otherhand, when a phyſician often employs a ſimple, and obſerves its effect; the relief or prejudice of the patient, may very probably, if not with medical certainty, be aſcrib'd to the good or bad qualities of that particular remedy.

And this difficulty, of diſcerning what particular ingredient of a very compounded medicine helps, or hurts a patient, is much increas'd to thoſe, who affect to preſcribe compoſitions of compounds. As when *Venice*-treacle, which, alone, conſiſts of above ſixty ſeveral ſimples, mithridate, and the like, are thrown, as ſo many ſingle ingredients, into a medicine. I had once ſome thoughts of drawing up a diſcourſe upon the difficulties of the medicinal art, and had provided many materials for ſuch a work, which I afterwards laid aſide, for fear it ſhould be miſemploy'd, to the prejudice of worthy phyſicians. But, among the difficulties that then occurred to me, I ſhall mention one, *viz.* that 'tis a harder work than moſt men think, to diſcover fully the nature, or the good and bad qualities, in reference to phyſic, of any ſingle plant, or other ſimple of the *Materia medica.* For, beſides the great difference that there may be in plants of the ſame denomination, according to the climate, the ſoil, the goodneſs of the ſeeds that produce it, the culture, or want of it, the time of the year, the ſeaſonableneſs, or intemperature of the weather, the time and manner of gathering and keeping it, the parts of it that are, and thoſe which are not made uſe of, together with numberleſs other circumſtances; beſides all theſe, I ſay, the unheeded textures of parts, that are thought of an uniform nature, and the length of time during which they have been kept, without being ſuſpected to be ſuperannuated, *&c.* may ſo greatly vary the nature of a plant, that I have ſometimes, almoſt in a trice, ſeen a notable diſparity in the parts of the ſame freſh leaf of a common herb. And, what is very remarkable, I have found, by trial purpoſely made, that ſome ſeeds, of common uſe in phyſic, will, by being diſtill'd at one time of the year, afford an acid ſpirit, or liquor; but, at another time of the year, tho' diſtill'd the ſame way, without any addition, a kind of urinous one, that contains a volatile ſalt; which in ſmell, taſt, and ſeveral operations, appeared to have a great affinity with the volatile ſalt of urine, or that of hartſhorn. And, indeed, ſo many things may be pertinently propos'd to be enquired into, with relation to any particular plant made uſe of by phyſicians, that, perhaps, they would be leſs inclined to throw numbers of them into one compoſition, if they were aware, how much uſeful employment the diſcovery of the qualities of a few ſingle plants would afford them. Yet, without knowing the properties of the ſeparate ingredients, that a phyſician preſcribes, it will be ſcarce poſſible for him to know, with ſufficient certainty, how the medicine made up of them will be qualified and operate. And I the leſs ſcruple to make this reflexion, becauſe *Galen* himſelf expreſly aſſerts, that "'tis abſolutely impoſſible

" to uſe a compound medicine properly, without being perfectly " acquainted with the virtue of the ſimples that compoſe it."

I preſume it will be eaſily allowed, that much of what has been ſaid in favour of ſimple medicines, may be extended to many of the remedies afforded us by chymiſtry. For, without now entering into the queſtion, whether the ſpirits, oils, and ſalts, obtained by the fire, are principles in the ſtrict ſenſe of the word; it will ſcarce be doubted, that the ſpirit, the oil, or the ſalt of a mixed body, chymically reſolved, is ſo ſlightly, or unequally compoſed, that the ingredient whence it takes its name, is far more predominant there, than when combined with others in the entire or uncompounded concrete. And, that ſuch ſuppoſed principles, or medicines, of a ſimple order, will prove very efficacious, may be juſtly argued from the great and beneficial effects of oil of vitriol, ſpirit of urine (a medicine of great uſe both externally and internally) ſpirit of hartſhorn, ſpirit of nitre, ſpirit of wine, and oil of turpentine: of which laſt I ſhall add, that, beſides the virtues already aſcribed to it, whilſt it retains its ſimplicity, it may, in many caſes, be employed as a menſtruum; and, by being combined with an ingredient or two, be made to afford various medicines; which, tho' but little compounded, are of great virtue. For, I have found it readily diſſolve camphire, maſtic, and ſome other gums, of which balſams may be made; and others may, by the help of the ſame liquor, be obtained, even from ſeveral mineral and metalline bodies. I will not inſiſt on ſo known a medicine as the common terebinthinate balſam of ſulphur, tho' this be a remedy, which, as much as 'tis peculiarly extoll'd for diſeaſes of the lungs, has virtues unconfined to the diſtempers of that part; ſince both I, and ſome I recommended it to, have found it very effectual, outwardly apply'd, in troubleſome hemorrhoidal pains and tumours: and experience inclines me to think, its virtues may not be much greater in pulmonic, than in paralytic diſtempers; in the latter of which it may be uſed not only outwardly, but, to more advantage, inwardly, and that in a pretty large doſe, with a cephalic, and, in ſome caſes, an anti-ſcorbutic vehicle. But I ſhall rather take notice, that, perhaps, it will be found worth while to try, at leaſt in external diſorders, the uſe of ſeveral tinctures, and conſequently balſams, that may be obtained by the help of oil of turpentine, from ſome ſolid mineral bodies; by which I have found, upon trial, this liquor may be tinged; and among them, I ſhall name, beſides crude zink, crude antimony, and even crude copper, a noble ſubject, antimonial cinnabar; from whence, tho' I could draw a fine tincture, I had not opportunity to make trial of ſo promiſing a medicine.

That chymical remedies, alſo, ſhould be ſimple.

6. And as for ſuch other medicines as are not made by bare analyſis, but by ſyntheſis, or compoſition; tho' I think an experienced chymiſt may, in many caſes, with leſs uncertainty than a *Galeniſt*, foreſee what quality the mixed body this way produced, may have;

yet I could wiſh, that chymiſts were more ſparing in the number of the ingredients they employ, to compoſe a ſingle medicine. For moſt of the arguments that ſhew the advantage of ſimple remedies, are alſo applicable to chymical ones.

In many caſes, preparations skilfully diverſifyed, may be uſefully ſubſtituted for compoſition; ſince one body dextrouſly expoſed to different operations, may acquire as various, or as conſiderable qualities, as would accrue to it by the addition of ſuch other materials, as an ordinary chymiſt would, in all probability, aſſociate with it. Thus, not to mention quick-ſilver, antimony alone, or aſſociated with one or two ingredients, may afford a variety of medicines, capable almoſt of furniſhing a ſhop; or, at leaſt, to anſwer the phyſician's intention, when he would employ an emetic, a cathartic, a diaphoretic, a deobſtruent, a diuretic, a bezoardic, or cordial medicine; to paſs over the other remarkable qualities that may be found in ſome antimonial preparations.

Again, without bringing together a chaos, or any great number of ingredients, one or two auxiliary ones, if judiciouſly choſen, and skilfully managed, may often produce more efficacious remedies, than the admirers of pompous proceſſes would expect. The violently emetic, and purgative virtue of glaſs of antimony, *per ſe*, may be, as we have ſeen, more powerfully corrected by mere diſtilled vinegar, than by many famous ſtomachic, or cordial elixirs, and other elaborate preparations. And, ſometimes, a ſeemingly improper addition may not only correct, but give new and unexpected virtues to a drug. Thus, tho' corroſive ſublimate be a very pernicious and fretting mercurial concrete, yet by adding, and carefully uniting to it, an equal weight of running mercury, there is thence, by ſublimation, obtained a compound, which, in skilful hands, may be uſefully employed, not only in ſome venereal affections, but in ſeveral other diſtempers. And this preparation, call'd *Mercurius dulcis*, being carefully made and apply'd, will greatly allay even the ſharpneſs both of ſome emptying medicines, and of ſome peccant humours. I remember, I had an opportunity to obſerve its efficacy in a ſtubborn dyſentery, that had baffled the remedies of an eminent phyſician. But, tho' a reflexion on the virtue I knew this medicine to have, in allaying ſharp humours, and reſiſting putrefaction, might juſtly give me a favourable opinion of it in this caſe; yet not thinking my own experience ſufficient, I imparted it to an ancient and experienced chirurgeon of the army, who frankly confeſs'd, that this was his great *Arcanum*, wherewith he had cured many hundreds of ſoldiers of the like diſtemper. But, as my way is to give from eight to fifteen grains of it, for a doſe, made up with a little rhubarb, or other ingredient, that would make it work once or twice; (for the dyſentery it ſelf helps to carry off the medicine) he made it up with ſugar and the mucilage of gum-dragon, into lozenges; each whereof might contain from near a ſcruple to half a dram, of the *Mercurius dulcis*: and of theſe he order'd the ſoldiers to take one at a time, without hindering their march; only giving them a great caution, that nothing of it ſhould ſtick between their teeth, or in their throats.

But the efficacy of this ſimple preparation of mercury, is much inferior to that more ſimple one of gold, made after the ſame manner, in two different countries, by two dextrous phyſicians, both of them my acquaintance. For, tho' I had been long prejudiced againſt the pretended *Aurum potabile*, and other boaſted preparations of gold, for moſt of which I have ſtill no great eſteem; yet I ſaw ſuch extraordinary and ſurprizing effects from the tincture of gold I ſpeak of, upon perſons of great note, with whom I was particularly acquainted, both before they fell deſperately ſick, and after their ſtrange recovery; that I could not but change my opinion for a very favourable one, as to ſome preparations of gold. But tho' this ſimple medicine can only be made in ſmall quantities, and that too not without a great deal of pains and time, I can ſpeak thus circumſtantially of it, becauſe by the kindneſs of the artiſts, and the pains I had beſtowed in working upon the ſame ſubject they uſe for their menſtruum, I ſo far knew, and partly ſaw the preparation of it, as to apply what has been ſaid, to the preſent occaſion. There is here but a ſingle ingredient aſſociated to the gold, and that comes from above, and is reputed one of the ſimpleſt bodies in nature; two or three ounces of which may be taken altogether unprepared, without the leaſt inconvenience. Yet the doſe of this almoſt inſipid medicine, that was given to an old courtier in a violent apoplexy, after other remedies had by skilful men been uſed in vain, was but ſix or eight drops.

In another very ancient and corpulent perſon, the doſe was greater; the tincture being then more unripe, and diluted: but the effect was as ſudden, tho' the patient were not bled; and tho' there was not in either of theſe caſes any remarkably ſenſible evacuation made. The two perſons thus recover'd are yet alive. The ſame medicine, a while after, ſaved the life of another gentleman, whom I know, that having lain above two and twenty days ſick of an ill-conditioned fever, was condemned by three phyſicians; one whereof told me, that he could not out-live the next morning; yet, upon taking of a large doſe of this tincture, he was preſently relieved; and from that time found a ſenſible amendment, and afterwards recover'd his health, which he now enjoys, tho' he was then reputed to be fourſcore years old. I could relate ſome other odd effects of this remedy; but the preſent may ſuffice to alleviate a prejudice againſt medicines, made of ſo fixed and ſuppoſed unalterable a metal as gold.

Nor is this the only medicine, made of that noble body, of which I have known very remarkable effects. My preparation of ſilver, tho' it may ſeem but ſlight, has proved very effectual, and been much uſed by one of the moſt eminent phyſicians of this nation, to whom I recommended it, and who acknowledg'd to me, that he gave it to patients, of very high quality, tho' diſguized, to avoid alarming thoſe that are fearful of chymical medicines. And ſince that, I gave it, with great ſucceſs, to a lady, who was hydropical, and judg'd to be dangerouſly ill; and the cure has already, for ſome years, held good. But, I confeſs, that I look upon copper, and its magiſtery, blue vitriol, as a much nobler ſubject to make remedies of, than ſilver, or, perhaps, than gold it ſelf. And if I were to make phyſic my profeſſion, there is no metal, which I ſhould ſo willingly beſtow pains upon, as copper. And to this I am induced by the excellent, and very extraordinary effects that I have ſeen of ſome remedies, which, tho' I could never learn how to make, I knew were compos'd of that metal, or the purified vitriol abounding in it. And for appeaſing of pains, produc'd by inveterate diſtempers, the laudanums, and other preparations, preſcrib'd, and praiſed by phyſicians, ſeem to me, becauſe of the ſtupor they induce, and ſome other inconvenient ſymptoms, far inferior to the ſulphureous parts of skilfully prepared copper; theſe being much more harmleſs and friendly anodynes. And, I remember, that an empiric, to whom I communicated a very uncertain way of making a kind of ſulphur of vitriol alone, in the form of a brick-colour'd powder, came purpoſely to give me thanks for the reputation he had gain'd by that medicine. Of this, the firſt time, he had the good luck to make it, he gave four or five grains to a woman, that could not ſleep, and that had been, for ſeveral months, raving mad; which ſingle doſe, not only procured her a good nights reſt, but brought her to talk ſenſe, when ſhe wak'd in the morning. I knew a chymiſt, who was much courted by learned phyſicians, for an internal anodyne he uſed, and could ſell at, almoſt, any rate, to take off inveterate pains in the head, and ſhins of venereal patients; the ſame perſon cured venereal ulcers in a very ſhort time, only by ſtrewing on them an indolent powder; and tho' he was exceeding ſhy of his medicine, I happen'd to get a ſight of it, and gueſs'd, by its weight and effects, that it was ſome preparation of mercury, fix'd with ſulphur of copper. Whereupon he frankly acknowledged, that tho' it would endure a ſtrong, and laſting fire, that, in the former part of my conjecture, I was in the right; and in the latter, ſhot very near the mark; but added, that the true ſulphureous parts of copper were, in his way, ſo difficult to be obtain'd, and required ſo much time, that he could ſeldom prevail with himſelf to go thro' ſo troubleſome a work. And, in effect, I found, upon various trials, the conſtituent parts of that metal to be much more ſtrictly united, than the generality of chymiſts imagine. *Helmont* ſays; that "nothing has a greater effect upon the "radical moiſture, than the *Ens primum* of copper; and nothing more "powerful to prolong life, than the ſulphur of vitriol". Both phyſicians, and chymiſts, make a great variety of remedies of ſteel; ſome of which are produced by ſlight preparations; and the like may be ſaid of mercury; witneſs the remedy, formerly commended againſt worms, made of nothing but crude quick-ſilver, barely boiled in common water: and the calx of lead, diſſolv'd in ſpirit of vinegar, affords *Saccharum Saturni*; which, tho' ſo eaſy and ſimple a preparation, is a magiſtery that has more virtues than every phyſician knows, or, perhaps, ſuſpects; eſpecially in mortifying ſharp humours in the eyes; which I have known it ſometimes do, almoſt in a trice, when well diluted with plantain, or roſe-water. And for burns, I have ſeldom ſeen any thing equal to it; and, therefore, have often uſed it upon my ſelf, barely diſſolv'd in common water: but, I fear, 'tis not ſo ſafe, as effectual, in ſome internal diſorders of the *viſcera*, judg'd to proceed from acid humours, unleſs it be warily and ſkilfully given. But, as to its external uſe, it is very powerful in healing, and, in the mean time, appeaſing the pains of ſeveral ſorts of ulcers. A very antient, and experienc'd chirurgeon, confeſs'd to me, that of all the medicines he has tried to ſtop bleeding, and prevent accidents in amputations; that which he moſt rely'd on, was a ſolution of *Saccharum Saturni*, in plantain, or common water. His method is, to diſſolve an ounce of the former, in about a pint of the latter; and as ſoon as ever the limb is taken off, immediately to apply ſtupes, drench'd in this liquor, as hot as the patient can well endure: and having bound them carefully on, he makes no haſt to take them off, but allows the medicine time enough to perform its operation.

What is here ſaid of metals, may be extended to minerals; for when there is need to compound them, it may often be ſufficient to aſſociate them with one or two auxiliary ingredients. This appears from ſeveral uſeful preparations of antimony, commonly known; to which ſeveral others may be added, that are made by ſlight additions of commonly ſulphur. But of this ſort I ſhall only mention one, whoſe medicinal virtues are very great, eſpecially in aſthma's and coughs, in which I do not remember, that I ever gave it, without benefit to the patient; nor was it leſs ſucceſsful in the hands of phyſicians, who were willing to try it for me; eſpecially in thoſe of a perſon, who, tho' well furniſh'd with choice remedies of his own, often came to me for a ſupply of this ſpirituous and penetrating tincture, with which he aſſured me he did notable things in aſthmatical caſes; and particularly in one, that was very obſtinate, and had laſted many years. This medicine is made of the flowers of ſulphur, exactly mix'd with an equal weight of ſal-armoniac, and more than an equal weight of good quick-lime, ſeparately reduced to fine powder. Theſe three ingredients being diligently and nimbly mix'd, and put into a retort, fitted with a large receiver, well luted to it, and duly diſtill'd in a ſand heat, will afford a blood-red and ſmoaking ſpirit, exceeding ſulphureous, both in ſmell and mechanical operations. And, in this diſtillation, we found the ſulphureous parts ſometimes came over accompany'd with ſuch ſtore of ſaline ones, that a good part of what paſs'd into the receiver, ſhot into the form of a volatile, ſulphureous ſalt.

Whether ſimple remedies may cure complex diſtempers.

7. It may be objected, againſt the frequent uſe of ſimple medicines, that a diſeaſe, or the morbific matter, is, often, not the effect of a ſingle cauſe; but produc'd by the concurrence of two or more, which, creating ſeveral ſymptoms, 'tis improbable that one ſimple will be able to anſwer the ſeveral indications. This objection is, I confeſs, conſiderable; and there are caſes, wherein I acknowledge it to be ſo weighty, as to warrant a phyſician to employ a medicine, conſiſting of ſeveral ingredients. But this interferes not with my deſign; ſince I formerly declar'd, I was not for confining any one to ſimple remedies, but wiſh phyſicians would only employ them where they may ſuffice.

Two or three conſiderations may, however, be offer'd, to leſſen the force of the preſent objection. And firſt, I readily grant, that ſometimes diſeaſes may proceed from different cauſes; and that a remedy may be available againſt them, when produced by one of thoſe cauſes, without being ſo when they flow from another; yet it may eaſily happen, that in one caſe the diſeaſe may be cured by one ſingle medicine, and in another, by a remedy not compounded. Nay, it is poſſible, the ſame ſimple may cure a diſtemper, by which ſoever of the two cauſes it is produced. And the effects of the *Peruvian* bark, in different kinds of agues, and of narcotic medicines, in appeaſing pains produced by humours, and other very different cauſes, render this aſſertion probable. And, if I miſtake not, it may frequently happen, that, whatever firſt produced a portion of morbific matter, this very matter may cauſe the continuance of the diſeaſe, by means of ſome peculiar texture, or noxious conſtitution, which if the generous medicine can deſtroy, the diſeaſe will ceaſe.

It often happens, that ſeveral very different ſymptoms may ſo depend upon the primary cauſe of the diſeaſe, that if a medicine, how ſimple ſoever, be able to deſtroy that cauſe, all the various ſymptoms will vaniſh of themſelves. Thus we ſee, that when mercury is ſkilfully apply'd, and raiſes a kindly ſalivation, a great variety of inconveniencies, that afflicted a venereal patient, and ſeem'd to require many different and topical applications, are remov'd by the ſame remedy; ſo that not only frightful ulcers, but ſuch nodes as one would think ſcarce poſſible to be diſſipated by the ſtrongeſt plaiſters, are ſometimes happily cured by well prepared quick-ſilver, taken at the mouth. And tho' there are ſeveral, and, ſometimes, very different ſymptoms, that accompany the rickets; yet the medicine, which I call *Ens veneris*, made of ſtrongly calcin'd, and well dulcify'd colcothar of *Dantzic* vitriol, and elevated with ſal-armoniac into the form of a reddiſh ſublimate, has prov'd ſo ſucceſsful, that I think I may ſafely ſay, two or three hundred children have, through my means,

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been cured by it, and that, almoſt, always without the help of any other inward medicine, or topical application.

But the principal thing I oppoſe, by way of anſwer, to the objection is, that in a ſimple medicine, nature, her ſelf, often renders the uſe of compoſitions unneceſſary; for tho' we are apt to look upon a plant, or mineral, as an entire and ſimple body, yet we may greatly miſtake, if we look upon it as homogeneous. In ſeveral plants, that are organical bodies, as, for inſtance, in oranges, the ſucculent part is ſour and cooling, but the yellow rind conſiderably hot and bitter; and ſo in lemmons, the pulp, the yellow part of the rind, and the ſeeds, have their different qualities and medicinal virtues: and even in ſuch vegetable ſubſtances, as are homogeneous as to ſenſe, there may be parts, whoſe operations are not only different, but contrary; as is manifeſt in rhubarb, which affords as well aſtringent as purgative parts. This holds, alſo, in minerals; thus good clean lead-ore, for inſtance, tho' an uniform body, as to ſenſe, conſiſts of very diſſimilar parts, and affords ſulphureous, and, perhaps, other recrements, beſides malleable lead, which is it ſelf a compound body. Thus, alſo, ſhining marcaſites, tho' they appear homogeneous, will, by being barely expos'd, for a competent time, to the moiſt air, afford an efloreſcence perfectly vitriolate; and conſequently contains an acid ſalt, two kinds of ſulphur, a terreſtrial matter, and, at leaſt, one metal; which latter ſubſtances themſelves, are neither of them ſimple bodies.

And if we admit the chymical analyſis of mix'd bodies to be genuine; we ſhall find that almoſt all thoſe belonging to the vegetable kingdom, or to the animal, and many that are referred to the mineral kingdom, how uniform ſoever they may appear to the eye, do, each of them, contain different, and ſometimes oppoſite ſubſtances. Thus hartſhorn, tho' it appears a dry and homogeneous matter, will, in diſtillation, afford a volatile ſalt, an urinous ſpirit, a wateriſh liquor, or phlegm, an oil that will ſwim, and another that will ſink in water, a white and porous earth, or *terra damnata*, and, perhaps, ſome fix'd ſalt. Thus, alſo, in the vegetable kingdom, tartar, for inſtance, may, without addition, be made to afford a volatile ſalt, very like that of urine, a phlegm, an acid ſpirit, another ſpirit, which I call adiaphorous, two fetid oils, whereof one will ſink in water, and the other ſwim, a *terra damnata*, and a fix'd lixivial ſalt, upon which the acid ſpirit manifeſts ſuch an hoſtility, that when put together, they tumultuate, with noiſe and bubbles, and in the conflict, mortify each other. So, likewiſe, in the mineral kingdom, we ſee native cinnabar affords, by diſtillation, beſides running mercury, a dry ſubſtance, whence I have obtain'd a ſulphur, that would, preſently, gild ſilver, and a terreſtrial matter, whoſe nature I did not examine. And I the rather take notice of theſe differing parts, in native cinnabar, becauſe it is a mineral that I much eſteem; and tho' here in *England* it is very rarely employ'd as an internal medicine, yet I know ſome phyſicians, of ſeveral nations, who look upon it as one of their chief *arcana*, and both uſe and conceal it accordingly. But I do not willingly employ this material, till it has been prepared by grinding upon a porphire, as a painter would do to make a pigment of it; and by freeing it from certain ſalts, that often, undiſcernedly, adhere to it, and may ſometimes prove hurtful. This is done by firſt waſhing it very carefully with boiling water; and then, after it has been throughly dry'd, by burning upon it, ſeveral times ſucceſſively, ſome vinous ſpirits perfectly dephlegmed. The doſe, if it be to be long continued, is three, four, or five grains; but when 'tis given ſeldom, and on urgent occaſions, from ſix to twelve grains.

8. Since a ſimple then, whether organical or not, may, notwithſtanding its entireneſs, or ſeeming uniformity, contain or afford very diſſimilar parts; and being therefore really a compound body, it may afford parts different enough to anſwer differing indications in the cure of diſeaſes. Thus, in many diarrheas, where 'tis judged requiſite to evacuate the peccant matter, and then to give aſtringents to hinder the immoderate evacuation, wherein the diſeaſe is thought to conſiſt; rhubarb anſwers both theſe indications, by its purgative and more terreſtrial parts; the former whereof diſpatch their work firſt, which makes the aſtringent operation of the latter ſafe and ſeaſonable.

I have often obſerved, that ſo common and deſpicable a ſimple as ground-ivy, has performed things, whoſe variety ſeem'd to argue, that it contains parts of very different virtues; and is thereby capable of anſwering different intentions, eſpecially in diſtempers of the lungs and breaſt: and, indeed, partly by the ſyrup of it, partly by the infuſion of the leaves, and partly by medicines made of them in a conſiſtent form, the happy effects of this plant have procured me the thanks of many conſiderable perſons; ſome of which had before unſucceſsfully try'd many preſcriptions of learned men. And I remember the maſter of a conſiderable manufacture, was very much incommoded and perplexed, to find his ſervants obnoxious to violent colics, which he imputed to the copious ſteams of the vinegar his art required; but from this inconvenience he was, at length, in great part, freed, by making them frequently uſe a ſtrong infuſion, or tincture, of the leaves of ground-ivy, prepared with good *Nantz* brandy.

I could here add many other uſes, both internal and external, of this ſeemingly deſpicable plant; and there is ſcarce any *Engliſh* herb, for its virtues manifeſted in the experience of others, and my own, that ſhares ſo much of my eſteem, as ground-ivy. And I am apt to think, that the virtues of this, and ſome other ſimples, would be found more numerous and powerful than is generally allowed, if phyſicians, in their preſcriptions, would more frequently either ordain ſimples, or join but very few together; and compenſate the ſmallneſs of the number, by the greater quantity of thoſe that are the moſt proper or operative; and order the uſe hereof to be continued for a competent time. 'Tis not, indeed, every efficacious ſimple, or lightly compounded remedy, that can be fitly employed for the proof of our doctrine; I ſhall, therefore, ſubjoin a few ſuch inſtances, as may ſuffice for the preſent occaſion.

Mineral waters, whether *Acidulæ*, as thoſe of the *German Spaw*, our *Tunbridge*, &c. or *Thermæ*, ſuch as thoſe of *Bath*, &c. tho' but natural medicines, are, ſome of them, by being outwardly adminiſtred, known, ſingly, and in their native ſimplicity, to cure ſeveral diſeaſes; and, conſequently, to take off a great number of different ſymptoms, which afford various indications. That the ſame ſimple may comprize qualities fit to anſwer different deſigns, and, therefore, cure different ſymptoms, ſeems probable; becauſe ſeveral poiſons, that do, each of them, produce various frightful ſymptoms, all which have been often conquer'd by a ſpecific antidote, that is, perhaps, but a ſimple herb, or other uncompounded drug.

Phyſicians, and others, have obſerved great variety of ſymptoms in the plague; among which there are ſeveral, each whereof, if ſingle, would paſs for a particular diſeaſe; and this diverſity of ſymptoms may be often obſerved, not only in peſtilences, that happen at times, or countries, diſtant from one another, but in the ſame plague reigning in the ſame place. Yet 'tis poſſible for a ſimple remedy to prove available againſt this ſo various and violent a diſeaſe. *Galen* himſelf, treating of the *Terra Samia*, takes occaſion to bring in the virtues of *Bolus Armena*. This earth, which appears ſo ſimple and uniform, he not only commends for ſeveral diſeaſes, as ſpitting of blood, fluxes of the belly, dyſenteries, catarrhs, defluxions, difficulty of breathing, and even ulcers of the lungs; but adds, what makes directly for our purpoſe, that "in a very ſevere plague, all who took this medicine early, " recover'd." " 'Twas taken," he ſays, " mix'd with ſmall white-wine, " diluted in proportion to the fever." He alſo declares, that " if this " remedy failed to relieve the patient, every thing elſe proved in" effectual."

There are few diſeaſes that appear in ſo many forms, with greater variety of ſymptoms, than that which phyſicians call *Affectio Hyſterica*, whoſe paroxyſms are vulgarly known in *England* by the name of fits of the mother: yet we have often ſuddenly removed theſe fits, by the bare odour of ſpirit of ſal-armoniac.

But to ſhew the efficacy even of dry and ſolid bodies, tho' but externally apply'd, in diſeaſes, attended with many uncommon ſymptoms, we might have recourſe to the ſtones, ſaid to be found in the heads of a certain kind of ſerpents about *Goa*, and ſome other *Eaſtern* countries. Moſt phyſicians, however, reject or queſtion the power aſcribed to them, for curing the bites of vipers: and, indeed, many of the ſtones brought from *India*, are counterfeit; and of thoſe that were really taken out of ſerpents, ſeveral will prove inſignificant; (and ſuch, perhaps, were thoſe that the learned *Rhedy* made his trials with;) yet there are others, whoſe virtues cannot well be deny'd. For one of the moſt eminent phyſicians of the *London* college aſſured me, he had with one of theſe ſtones, contrary to his expectation, performed a notable cure, which he related to me, at large. And a very famous *Engliſh* chirurgeon affirmed to me, that he had done the like upon another perſon; both of theſe cures being performed by the bare application of the ſtone, to the place bitten by the viper. A very intelligent perſon, alſo, who had the direction of a conſiderable company of traders in *Eaſt-India*, where he long lived, aſſured me, he had with this ſtone cured ſeveral perſons of the hurts of venomous animals. But this teſtimony is much leſs conſiderable, as to the number of cures, than that of a great traveller into the ſouthern parts of the ſame *India*; who ſeriouſly aſſured me, he had cured above ſixty perſons of the bites or ſtings of ſeveral ſorts of poiſonous creatures; and that he performed moſt of thoſe cures by the outward application of one ſtone; becauſe, finding it excellent, he was invited to keep to it, eſpecially in difficult caſes. And this, ſome experience of my own, made with a genuine ſtone of the ſame kind, upon the bodies of brutes, much inclines me to give credit to.

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I had once the opportunity of making a trial of the virtue of a ſtone, taken out of the head of an enormouſly great *African* ſerpent. This ſtone was affirmed to its poſſeſſor, the governour of the *Engliſh Eaſt-India* company, to be highly available againſt the bites of all venomous animals. And, indeed, a little of it recover'd a cat from two dangerous bites of a fierce and enraged viper, after we had deſpaired of his life, on account of the violent ſymptoms that enſued.

But becauſe this ſtone is afforded by an animal, I ſhall, for a concluſion, add the virtues of another, that properly belongs to the mineral kingdom, in a diſeaſe, whoſe ſymptoms, tho' not ſo various, are ſometimes dangerous, and too often mortal.

There was once ſhewed to me a cloſe and hard ſolid body, which paſs'd for a blood-ſtone, tho' by its colour, and ſome other viſible qualities, I ſhould rather have taken it for an agate, about the bigneſs of a ſmall nutmeg, that had been long kept in the family wherein I ſaw it; being, for its rare virtues, tranſmitted from one to another. I ſhall not relate all the reports made of this ſtone; but I think the following particular of it is very remarkable. An ingenious gentleman, in the flower of his age, and of a complexion very highly ſanguine, was, from time to time, ſubject to hemorrhages at the noſe, ſo profuſe and difficult to be reſtrained, that his phyſician, tho' a perſon famous, and very well skill'd in his art, told me, he often fear'd he ſhould loſe his patient. But when a good method, and variety of remedies had been try'd, without the deſired ſucceſs, this ſtone was, at length, obtained to tie about his neck, ſo as to touch his naked skin; which being done in the fits, it would ſtop the bleeding; and if he wore it for ſome conſiderable time together, he all that while continued well; as both his phyſician, and himſelf informed me. And becauſe I was apt to aſcribe ſomewhat of this effect to imagination, the patient told me, that a while before, one of the chief women in the city fell into ſo violent a bleeding, that tho' it made her ſwoon, yet the hemorrhage ſtill continued, till the ſtone having been tied about her neck, ſtopp'd it; whilſt ſhe knew nothing of its being apply'd. And this is ſtill leſs ſtrange, than what the gentleman affirm'd to me of the power of the ſame ſtone; for his complexion inclining him to breed great plenty of blood, his phyſician order'd him, by way of prevention, to breathe a vein from time to time; but, in preparing for this operation, he was obliged to lay aſide the ſtone, becauſe the blood would not otherwiſe iſſue with the requiſite freedom.

SOME

Uncommon Obſervations

UPON

VITIATED SIGHT.

White objec
the moſt v
ble, to a di
ſight.

1. A Gentleman, who was almoſt blind, from a blow he received upon his head, told me, that tho' he could not well diſtinguiſh colour'd objects, yet he clearly perceived thoſe that were white; which ſhews, there is a greater quantity of light reflected by white objects than others. And I had the like affirm'd to me by another perſon, who was almoſt blind.

2. I knew a gentleman afflicted with a cataract, which, when I looked on his eye, in a light place, appear'd to cover almoſt the upper part of the pupil; and tho' he were young and vigorous, he could not, in the cleareſt weather, well diſcern men from women, croſs a ſtreet. This misfortune proceeded from a great blow he received, on the ſame ſide of his head; which circumſtance I note, becauſe when no outward violence has been offer'd to the eye, an eminent oculiſt obſerves, and I have ſeen an inſtance of it, that a ſmall part of the pupil left uncover'd by the cataract, would ſerve for a greater ſhare of viſion, than this gentleman enjoyed. But, even in this caſe, he alſo could diſtinguiſh white objects better than others.

Cataracts
the eyes.

3. Meeting, accidentally, with a man, whoſe eyes appeared very oddly, I queſtion'd him about his diſtemper; and found by his anſwers, that he had been afflicted with cataracts in both his eyes, which were either ill couched, or he had not managed himſelf regularly afterwards. For, there ſeemed ſtill to remain ragged films, that cover'd conſiderable portions of his pupils, ſo that I wonder'd to ſee him walk about without aſſiſtance: he ſaid, however, that he could read a large print, by the help of his cataract-ſpectacles; but, upon producing a book, I found he could not make out the title-page, becauſe the place happen'd

to be too light; which, tho' it appear'd improbable, yet having cauſed the room to be a little darken'd, I then perceiv'd he could read well enough.

4. A gentleman having received a violent blow on the ſide of his head, found, afterwards, a great weakneſs and dimneſs of ſight to enſue; and looking attentively upon his eyes, I plainly diſcern'd, that tho' above half the pupil of one eye remain'd uncover'd; ſo that when he look'd downwards, he could ſee very well with that eye; yet there were grown in it two cataracts, which, when carefully view'd in a good light, I plainly perceived to be diſtinct; the one of them ſeeming to be ſmoothly ſpread, as if its circular edge adhered cloſely to the inſide of the eye; the other, which ſeem'd not quite of the ſame colour, hanging looſely, and like a rag, at ſome diſtance above it.

Objects appearing dark and double.

5. A learned gentleman coming once to viſit me, with deſign to learn my opinion, concerning an odd diſtemper he had in his eyes; I found, by diſcourſing with him, that tho', when he look'd on things near at hand, he ſaw them ſomewhat dimly, but ſingle; yet there were ſome objects, particularly poſts and rails, which when he beheld at a certain ſmall diſtance, they appear'd to him both dark and double. He alſo, complain'd of many black flies, and little leaves, which paſs'd, now and then, before his eyes; which tho' they do not always foretel a true cataract; ſince I have obſerv'd them to continue many years without more than a baſtard ſuffuſion enſuing; yet in him they were, probably, fore-runners of a true cataract; becauſe I have known it obſerv'd, by a skilful oculiſt, that perſons, before the formation of their cataract, have complain'd they ſaw objects at ſome diſtances almoſt double; ſo that looking at the head of a man, they thought they ſaw a great part of a dark head a little above it: which phenomenon, whether it proceed from ſome refractions made by the yet unequally opake matter of the cataract, not having opportunity to examine, I dare not venture to ſay.

Cataracts happily couched.

6. It may be worth obſerving, how long the more kindly ſort of cataracts, tho' they hinder the ſight for a time, as a thick curtain drawn over the pupil, may remain in the eye, without ſpoiling the optic nerve, or deſtroying viſion, after the diſtemper is remov'd. I remember, among other inſtances, a woman told me ſhe had cataracts in her eyes ſo long, that ſhe was deliver'd of ſix children, ſucceſſively, without being able to ſee any one of them, till after ſhe had been couch'd; upon which, ſhe could read a ſmall print, with ſpectacles. And ſeveral conſiderable perſons, of my acquaintance, ſaw one, of eighteen years old, born with cataracts in both her eyes, who had been ſo happily couch'd, as thence to receive the benefit of ſight in them both.

Both eyes concern'd in real viſion.

7. It has, of late, been the opinion of very learned men, that tho' both our eyes are open, and turn'd towards an object, yet but one of them at a time, is effectually employ'd, in giving us the true repre-

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ſentation of it. But there will be a variation herein, according to the ſeveral habits and conſtitutions of the eyes of different perſons. For I have, by an experiment, purpoſely made, ſeveral times found, that my two eyes together, beheld an object in another ſituation, than either of them apart would do. On the contrary, I met with a perſon, who told me he had a cataract in his eye, for two or three years, without finding any impediment in his ſight; tho' others had, during that time, taken notice of a white film that croſs'd his eye, till, at length, happening to rub his ſound eye, he was ſurpriz'd to find himſelf in the dark; upon which, an oculiſt aſſured him, it was a cataract. But a very ingenious perſon, had, by an accident, one of his eyes ſtruck out, who told me, that, for ſome months after, he was apt to miſtake the ſituation and diſtance of things; for, having frequent occaſion to pour liquors out of one vial into another, after this misfortune, he often ſpilt them, and let them run quite beſide the necks of the vials, he thought he was pouring them directly into. Another gentleman, alſo, who had, by a wound, loſt the uſe of one of his eyes, confeſs'd to me, that, for ſome time after, he often, in pouring out his wine, miſs'd the mouth of the bottle, or glaſs, that ſhould receive it. A yet more conſiderable inſtance, of this kind, I met with in a noble perſon, who, in a fight, had one of his eyes ſtrangely mangled by a musket-ball, which came out at his mouth; for he told me, that he could not well pour drink out of one veſſel into another, and had broken many glaſſes by letting them fall out of his hand, when he thought he had given them to another, or ſet them down upon the table: he added, that this aptneſs to misjudge of diſtances and ſituation, continued with him, tho' not in the ſame degree, for little leſs than two years. I have often employ'd a dextrous artificer, whoſe right eye is conſtantly drawn ſo much aſide, towards the greater angle, that the edge of the pupil, almoſt, touches it; whence one would think it ſcarce poſſible, but he ſhould ſee objects double with two eyes, that ſeem ſo very differently turn'd; for the other remains natural; yet he finds no inconvenience from hence, except deformity, for he reads as freely as other men. This diſorder befel him thro' miſtaking ſublimate, for another thing; after which, it ſeems, one of the muſcles, that moved the eye, remain'd contracted. But as he had been thus, ever ſince he was two years of age, he could not remember whether he had ſeen objects double, before he was accuſtomed to judge of them by the help of his other ſenſes, and the information of others.

The parts the eye capable of great dilatation, without prejudice.

8. 'Tis worth obſerving, that a very great diſtention may be made of the parts of the eye, without ſpoiling of the ſight. Of this I lately ſaw an inſtance in a patient of that experienced oculiſt, Dr. *Turbervill*: A gentlewoman about two and twenty years of age, whoſe complexion and features would have render'd her handſome, had it not been for that ſort of eyes which ſome call ox-eyes; for they were ſwelled ſo much

beyond the ſize of human eyes, that ſhe complain'd they often frighted thoſe who ſaw her; and were, indeed, ſo big, that ſhe could not move them to the right hand, or the left, but was obliged to look ſtreight forward; or if ſhe would ſee an object that lay on one ſide, ſhe was oblig'd to turn her whole head that way. And this was her caſe when ſhe went to read; unleſs, with her hand, ſhe mov'd the book from one ſide to another, to bring the ends of the lines directly before her eyes. She ſaid her eyes were not always equally tumid, and that the day I ſaw them, they had been, in the morning, much more ſwell'd. But, what is more remarkable, ſhe could, for all this, not only ſee very well and diſtinctly, but her ſight continued good, tho' this diſtemper had been upon her for twelve years. Nay, ſhe declar'd, that when this diſorder firſt came on, ſhe knew of nothing that was amiſs in her eyes, till her friends told her of it, after they found it of too long a continuance to be a caſual tumour. It, however, occaſioned great pain in her eyes; for which ſhe took ſeveral medicines with ſo little ſucceſs, that both ſhe, and her former phyſicians, thought the caſe deſperate: upon which I propos'd a ſalivation; but the modeſt patient would by no means conſent to it.

A dimneſs of ſight in the day-time.

9. I once look'd into the eyes of a gentlewoman, where I could diſcern nothing amiſs, or unuſual, except the narrowneſs of her pupils, which is often eſteem'd a good ſign; yet ſhe was much troubled with fumes, and weakneſs in her head; and had a very uncommon diſorder in her ſight: for in the day time, ſhe ſaid it was ſo dim, that ſhe could hardly diſcern her way; but that ſoon after ſun-ſet, and during the twilight, ſhe ſaw far better: and thus ſhe continued for a long time. This brings to mind an odd caſe of an old learned divine, who complain'd to me, that, during the day time, his right hand ſhook ſo much, that he could not manage his pen; and, therefore, was forc'd to make uſe of it only by candle light. I remember, that upon his preſſing me to aſſign ſome poſſible cauſe of ſo odd a phenomenon, I told him, to put him off, that, perhaps, the few animal ſpirits he had to move his hands with, were ſo ſubtile, as to be diſſipated, or exhal'd, by the warmth of the day, but were kept in by the coldneſs of the night, that conſtipated the pores; and thereupon recommended to him the uſe of ſtrengthening things; and among the reſt, of chocolate; which, having continued to drink, for ſome time, he came and told me, with joy, that he began again to be able to write in the day; and ſo, I think, he ſtill continues to do.

The appearance of fire paſſing before the eyes.

10. Being acquainted with two ladies, of very different ages, but very near of kin, who were both of them troubled with diſtempers, that made me gueſs their eyes might, ſometimes, be oddly afflicted; I learnt, upon inquiry, that one of them, often thought ſhe ſaw numberleſs ſparks of fire, that were very unwelcome to her; and the other, who was ſubject to convulſions, tho' not epileptic, told me, ſhe

frequently ſaw, as ſhe fancied, the like flaſhes of fire paſs before her eyes, which at firſt greatly affrighted her.

Colours ap
pearing diff
rent to diſo
der'd organs

11. A gentlewoman about twenty years old, in whoſe eyes, tho' I could diſcern nothing unuſual, or amiſs, ſaid, that, about five years before I ſaw her, having been, upon a certain occaſion, immoderately tormented with bliſters, applied to her neck, and other parts, ſhe was quite deprived of her ſight; that, ſome time after this, ſhe began to perceive the light, but nothing by the help of it; that, then ſhe could ſee a window, without diſcerning the panes, or the bars thereof; that, afterwards, ſhe grew able to diſtinguiſh the ſhapes of bodies, and ſome of their colours; and that, at laſt, ſhe could ſee the minuteſt object: and preſenting her a book, ſhe not only, without heſitancy, read in it a line or two, but having pointed with my finger at a place of the margin, near which there was the part of a very little ſpeck, that might almoſt be cover'd with the point of a pin, ſhe readily found it out; and ſhew'd me at ſome diſtance from it, another yet more minute, that required a ſharp ſight to diſcern it. 'Twas now about noon; but ſhe told me ſhe could ſee much better in the evening, than in any lighter time of the day. I asked her, if the letters of the paper I ſhewed her, appeared black to her, and the paper white. To which ſhe anſwer'd, that they did ſo; but that ſhe ſaw, as it were, a white glaſs laid over both the objects. Two things were particularly odd in this caſe; for firſt, ſhe is often troubled with flaſhes of lightning, that ſeem to iſſue out like flames, about the external angle of her eye, and often make her ſtart, put her into frights, and give her melancholy thoughts. Secondly, which is more ſtrange and ſingular, ſhe can diſtinguiſh ſome colours, as black and white; but not others, eſpecially red and green. And when I produced her a bag of a fine gloſſy red, with tufts of sky-coloured ſilk, ſhe looked attentively upon it, but told me, that, to her, it did not ſeem red, but of a dark or dirty colour; and the tufts of ſilk, ſhe ſaid, ſeem'd to be of a light colour, which ſhe compared to the colour of the ſilken ſtuff of the lady's petticoat, who brought her to me: and, indeed, the blues were very much alike. She further ſaid, that the meadows did not appear green, but of an odd darkiſh colour; and that when ſhe had a mind to gather violets, tho' ſhe kneel'd in the place where they grew, ſhe could not diſtinguiſh them, by the colour, from the graſs about them, but only by their ſhape or touch. And the lady who was with her, took thence occaſion to tell me, that when ſhe looks upon a *Turkey* carpet, ſhe cannot diſtinguiſh the colours, unleſs of thoſe parts that were white or black. I asked, whether ſhe were not troubled with female obſtructions; to which ſhe anſwer'd, not now, but formerly very much.

12. I lately convers'd with a mathematician, eminent for his skill in optics, whoſe organs of viſion are ſo conſtituted, that, tho' in his eyes I could diſcern nothing unuſual, and tho' he makes frequent uſe

of them in aſtronomical obſervations, and optical experiments, yet he confeſs'd to me, that there are ſome colours which he conſtantly ſees amiſs; and particularly inſtanced in one which ſeemed dark to him, whilſt to me and others it appear'd quite different.

13. A lady, who has been long troubled with a very unuſual diſorder in her head, and who, tho' ſhe looks well, is never without pain in that part, told me, that after violent fits hereof, which ſhe has ſuffer'd from time to time, if ſhe did but turn her eyes, ſuddenly, from one ſide to the other, a convulſive motion in one of them would preſently enſue; upon which, all white objects, and moſt others ſhe look'd on with that eye, appeared green. And yet this was not a tranſient diſcompoſure that would go quickly off, but continued for a good while, and frequently return'd upon her, for a whole year together; ſo that ſhe deſpair'd of recovering the uſe of that eye, wherewith ſhe, nevertheleſs, ſees now very well; tho' her cephalic diſtempers are not quite cured. And if ſhe goes to read whilſt the convulſion is upon her, the letters are ſo apt to appear double, that if ſhe reſolves to continue reading, ſhe is obliged to ſhut the diſtemper'd eye, and employ only the other.

A great dilatation of the pupilla in the dark.

14. There was a gentleman of great courage and good parts, major to one of the regiments of king *Charles* I; who being afterwards forc'd abroad, ventur'd, at *Madrid*, to do his king a piece of ſervice, of an extraordinary nature and conſequence, and there judg'd very irregular. Upon this he was committed to an uncommon priſon, which had no window belonging to it, only a hole in the wall, at which the keeper put in proviſion, and preſently clos'd it again on the outſide; but not perhaps very exactly. For ſome weeks, this gentleman continued in the dark, very diſconſolate, but afterwards he began to think he ſaw ſome little glimmering of light, which, from time to time, increaſed ſo, that he could not only diſcover the parts of his bed, and other ſuch large objects, but, at length, perceived the mice that frequented his chamber, to eat the crumbs of bread which fell upon the ground, and diſcern'd their motions very well. Several other particulars of his ſight in that dark place he related; but when, after ſome months, the face of affairs was changed, and this gentleman ſet at liberty, he durſt not leave his priſon on the ſudden, for fear of loſing his ſight by the dazzling light of the day; and, therefore, accuſtomed his eyes to it by ſlow degrees. This relation I had from the gentleman's own mouth.

A
COLLECTION
OF
REMEDIES,
Gain'd from particular experiments, made in the curative part of medicine.

The nature and deſign of this collection.

'TIS here my deſign to communicate the receipts of ſuch medicines, as, by competent experience, have been found ſerviceable. Phyſic, indeed, is not my profeſſion, yet I hope I may publiſh a collection of remedies, without incurring the cenſure of equitable perſons; ſince 'twas a regard to the good of mankind that induced me to it. And did ſuch a practice ſtand in need of precedents and examples to patronize it, very eminent perſons, both among the ancients and moderns, would abundantly afford them.

The major part of the following receipts is, chiefly, deſign'd for the uſe of the generality, and thoſe who cannot well procure the aſſiſtance of a phyſician; and becauſe ſuch perſons are more frequently expoſed to external injuries, as ſtrains, bruiſes, tumours, &c. I purpoſely procured, from eminent ſurgeons and practitioners, a number of remedies, that, having been found very effectual in ſuch caſes, might be uſeful in this collection. However, I am not ſo much an empiric, as to recommend any remedies for certain and infallible cures, in the caſes wherein they are proper. He muſt either be very happy, or very little verſed in phyſic, who has never found the moſt celebrated medicines ineffectual. And, indeed, the cauſes and complications of diſeaſes, and the conſtitutions of patients, are ſo various, intricate, and obſcure, that 'tis extremely difficult, for the moſt experienced phyſician, to make an accurate experiment in the curative part of his profeſſion. I, therefore, ſolemnly profeſs, that I do not ſet down medicinal experiments, with the ſame poſitiveneſs I do thoſe in philoſophy; nor venture my reputation upon the ſucceſs of any receipt, or proceſs in medicine. Theſe, however, I always deliver faithfully; nor have I, upon uncertain rumours, recorded the virtues of particular remedies; which may be good without being infallible. And we muſt not be ſo weak, or fearful, as to perſuade our ſelves, if a patient miſcarries after the uſe of remedies, that the fault was in the medicine. For, in ſpite of our endeavours, the peccant matter will often be tranſlated, and the conſtitution impair'd; and the conflict of ſtruggling nature, and the conquering diſeaſe, muſt ſometimes manifeſt it ſelf in horrid ſymptoms; which the envious, or ignorant, unjuſtly aſcribe to the remedy: not conſidering that the like phenomena attend deſperate diſeaſes, and dying perſons, where no remedies at all are adminiſtred.

I muſt further declare, that I do not pretend the remedies I communicate, ſhould be phyſic and phyſician too; or of themſelves cure the diſeaſes for which they are recommended. For, medicines are but inſtruments in the hands of a phyſician, and require skill to manage them. I am, therefore, ſurprized at their boldneſs, who venture to practiſe phyſic barely upon the confidence of good receipts. Whoever acts as a phyſician, ſhould, at leaſt, have a competent knowledge of anatomy, the hiſtory of diſeaſes, of the *Materia medica*, and the chief ways of compounding ſeveral ingredients into medicines, of different forms and conſiſtencies, as circumſtances may require. He who has only one good receipt for a diſtemper, and knows not how to vary it, by occaſionally adding, omitting, or ſubſtituting other parts of the *Materia medica*, muſt frequently ſuffer his patient to languiſh helpleſs; or attempt to cure him of one diſeaſe, by throwing him into another. I know, for inſtance, ſome eminent phyſicians, who cure very ſtubborn venereal caſes, by a chymical preparation of ſarſaparilla, guaiacum, *&c.* but if theſe gentlemen meet with ſuch patients, as *Euſtachius Rudius* often did, to whom guaiacum would immediately give ſo great a ſharpneſs of urine, and inflammation of the urinary parts, as to hazard their lives; they muſt be reduced, as well as he was, to uſe mercurial, or other remedies.

It, alſo, ſometimes happens, that the very form of the medicine order'd in the receipt, renders it unfit, or impoſſible to be adminiſtred. A phyſician of my acquaintance was call'd to a patient, ſeiz'd with ſuch a conſtriction of the parts ſerving to deglutition and ſpeech, as render'd her wholly unable either to ſwallow, or to ſpeak; and thus ſhe continued for ſeveral days, notwithſtanding ſome emetic preparations that were put into her mouth; till, at length, a glyſter was luckily preſcribed, with four ounces of the infuſion of *Crocus metallorum*; upon which, there ſoon followed ſome violent vomitings, and a freedom of ſpeech and ſwallowing. And ſince this, a young gentleman and fellow-traveller of mine, was taken in the ſame manner; ſo that he was apprehenſive of being ſtarv'd in a very few days: and doubtleſs he had ſoon died, if a very happy phyſician had not, by an effectual ſpecific medicine, externally applied, ſeaſonably relieved him.

I would not, however, that a phyſician's ſkill ſhould make him deſpiſe good receipts; for we have often ſeen, not only empirics and ſurgeons, but even ladies and old-wives, with a lucky receipt, perform more conſtant and eaſy cures of a particular diſtemper, than even learned phyſicians by their pompous and artificial preſcriptions. The illuſtrious lord *Verulam* takes notice of it as a deficiency, that receipts, approved by long experience, are not more cloſely and religiouſly adhered to. And the experienced *Crato* doubts not, that a try'd remedy, rationally applied, may ſometimes prove more effectual, than an extemperaneous one judiciouſly preſcribed, by the moſt expert phyſician.

But if a medicine be powerful and commanding, the efficacy of it may ſupply a great want of ſkill in the preſcriber. And, indeed, there are certain preparations and compoſitions of medicines ſo lucky, and beyond expectation ſucceſsful, that the phyſicians who preſcribed them, may write down an hundred others, each apparently as rational as any of theſe, which, nevertheleſs, ſhall be all much inferior to the firſt. 'Tis, therefore, no wonder, that learned phyſicians have highly valued ſome particular receipts and proceſſes.

Upon the whole, 'tis rational to expect, that the nobleneſs of medicines will be advanced, as the art of preparing them ſhall be promoted; but ordinary receipts, without an ordinary meaſure of ſkill in phyſic, are not raſhly to be relied on; eſpecially in acute diſeaſes: yet if there be noble and extraordinary ſpecifics, that work rather by ſtrengthening and reſtoring nature, and reſolving the morbific matter, than by irritating, weakening, or diſordering her; the adminiſtration of ſuch remedies may, perhaps, uſually require only common diſcretion, and the obſervance of ſuch directions as may be given along with the medicine.

Thus much I thought fit to premiſe, that my deſign in publiſhing the following collection of remedies, or medicinal experiments, might not be miſunderſtood or perverted.

A plaiſter for aches, eſpecially if ſcorbutic.

Remedies for aches.

1. Spread thinly upon very fine kid-leather, the *Emplaſtrum de mucilaginibus*, and let it lie upon the aching part, as long as there is need.

For an old ach or ſtrain.

2. Take of *Lucatellus*'s balſam one ounce, of oil of turpentine one dram; incorporate them very well, with a gentle heat, and anoint the part affected therewith; wearing on it a piece of unwaſh'd flanel, beſmear'd with the ſame ointment.

For ſcorbutic aches, eſpecially about the ſhare-bone.

3. Take two parts of palm-oil, and one of oil of camomile; mix theſe exactly, and therewith anoint the part affected.

A powerful remedy for ſcorbutic aches.

4. To one ounce of oil of turpentine, put one dram or two, of the volatile ſalt of hartſhorn, or as much as, being well ground with it in a marble mortar, will bring it to the conſiſtence of a kind of ointment; with which, the cold being taken off, the part affected is to be lightly anointed.

For ſlight ſcorbutic aches or pains.

5. Anoint the pained part, from time to time, with faſting-ſpittle; and if you will have the medicine a little ſtronger, the patient may put roch-alum, to the bigneſs of a ſmall pea, into his mouth, before he employs his ſpittle.

For aches, and pricking pains in the ſides, or elſewhere.

6. With a ſufficient quantity of clean ſulphur, finely powder'd, mix as much *Venice*-treacle, as will bring it to a conſiſtence for pills. Of this mixture you may give the quantity of a piſtol-bullet, twice or thrice a day; drinking any convenient liquor after it.

For acidities in the blood.

Acidities. 7. Take coral, the cleareſt and reddeſt you can get, and reduce it to an impalpable powder. Of this give the patient, once or twice a day, as need ſhall require, about one dram at a time; and let him long continue the uſe of it.

To bring away the after-birth.

After-birth. 8. Give about 30 drops, or any number between 25 and 35, of good eſſential oil of juniper, in a draught of any convenient vehicle.

An external medicine, often ſucceſsfully try'd for agues.

Agues. 9. Take five, ſeven, or nine (for 'tis pretended it muſt be an odd number) of the roots of rib-wort; and having made them clean, put them into a little bag of ſarſenet, or fine linen, and let the patient wear it upon the nape of his neck; renewing it within two, three, or four days, if need require.

A try'd remedy for agues.

10. Take of the bark of ſaſſafras-root, and of *Virginia* ſnake-weed, both in powder, of each ten grains; and with half a dram, or two ſcruples of mithridate, or *Venice*-treacle, make a bolus; to be taken two hours before the cold fit.

A choice medicine for aguiſh diſtempers.

11. Take of ſalt of wormwood fifteen grains, crabs eyes eight or ten grains; mix theſe well, and give them in two or three ſpoons-full of ſome cordial-water.

A wriſt-plaiſter for agues.

12. Spread wax, to about the thickneſs of a crown-piece, and of a convenient breadth and length, to make an entire wriſt-plaiſter; upon this diſplay the leaves of the tops of rue, not yet fully open'd, ſo that they may cover the whole plaiſter; then apply it, and let it lie on for ſeveral days, ſucceſſively.

An often try'd medicine for agues.

13. Gather the leaves of rib-wort, as near the root as you can, in a dry morning; wipe them clean, but do not waſh them; then dry them carefully, till you may reduce them to powder. Of this give from one dram to two, mixt with one dram of conſerve of roſes, the crumbs of white bread, or the yolk of an egg or two.

For agues, eſpecially tertians.

14. Give as much *Virginia* ſnake-root, reduced to fine powder, as will lie upon a ſhilling, in a glaſs of ſherry, juſt before the beginning of the cold fit; repeating it once or twice if need be.

For a tertian ague.

15. Of the root of angelica powder'd, give from half a dram to a dram, in any convenient vehicle, about two hours before the cold fit.

A medicine with which a quartan was cur'd, when the bark had fail'd.

16. Let the patient take one dram of the black tips of crabs-claws, reduc'd to exceeding fine powder, in any convenient vehicle or conſerve, twice or thrice a day, as he would take the *cortex*, without intermitting.

To prevent or cure an ague.

17. Take grated angelica-root, flowers of antimony, of each half a dram, canary three ounces: infuſe them in a cold place for two days, and pour off the clear for two doſes. It is a ſingular good vomit for the cure of agues of all ſorts, being given in the morning faſting, four or ſix hours before the fit; and if it be not a quotidian ague, on the intermitting day.

An often try'd pericarpium for agues, eſpecially tertians.

18. Take a handful and a half of freſh rue, half a handful of freſh ſage, a ſmall ſpoonfull of bay-ſalt, and a ſpoonfull of good vinegar. Beat all theſe very well together into an uniform maſs; which divide

into two parts; and make thereof two wriſt-plaiſters, to be apply'd before the fit; and renew'd, if there be occaſion, and kept on till they grow dry and troubleſome.

An amulet againſt agues, eſpecially tertian.

19. Cut a handful of groundſel ſmall, put it into a ſquare paper-bag, about four inches every way; pricking that ſide which is to be next the ſkin, full of large holes; and cover it with ſome fine linen, that nothing may fall out. Let the patient wear this upon the pit of his ſtomach; renewing it two hours before every fit.

An often try'd remedy for an ague.

20. Boil yarrow in new milk, till it be tender enough for a cataplaſm. Apply this to the patient's wriſts, juſt when the cold fit is coming; and let it lie on till the fit is gone; and if another fit comes, uſe freſh cataplaſms as before.

For an ague.

21. Take the bone, called *Patella*, of the knee of a dead man; and having reduced it to fine powder, give of it as much as will lie upon a ſix-pence, for one doſe, in any proper conſerve, or vehicle, before the cold fit.

For agues.

22. Take ſalt of carduus, and ſalt of wormwood, each fifteen grains, tartar of vitriol half a ſcruple; mix them, and give them in a few ſpoonsfull of *Rheniſh* wine, or of ſome other convenient vehicle, either before the fit, or at ſome other time when the ſtomach is empty.

For taking off the fits of agues.

23. Give of good common brimſtone, reduced to a ſubtile powder, one dram and a half, or two drams, either made up into a bolus with a little honey, or in any appropriated vehicle; let it be given at the uſual times, and repeated once or twice, if need be, eſpecially if the fits ſhould return.

A medicine almoſt ſpecific for agues.

24. Take roſin of ſcammony twelve grains, diaphoretic antimony, and cryſtals of tartar, of each eight grains; mix theſe carefully, and give them for one doſe, an hour before the fit comes.

For an ague.

25. Take the ſoot of a baker's chimney, muſtard, rue, white-wine vinegar, ſallad-oil, ſome white pepper and ginger; make a poultis of them, and lay it to the pulſe of the arms, and let it lie on for a fortnight or three weeks.

An often try'd medicine for tertian agues.

26. Take of alum and nutmeg powder'd, of each about half a dram; mix them with about ſix grains of ſaffron; and give this in two or three ſpoonsfull of white-wine vinegar, at the uſual time.

An experienced remedy for an Anaſarca, *or general dropſy of the whole body.*

Anaſarca.

27. Fry freſh rue with oil of walnuts, till it becomes fit to be apply'd, hot, as a cataplaſm, to the navel; and keep it on that part for ſome hours; renewing it once or twice a day, if need require.

A powerful remedy in apoplectic fits.

Apoplexy.

28. From the herb maſtic, diſtil by an alembic, with a copper body, an eſſential oil; of which, with ſuch a pipe or quill, that one end may be open'd and ſtopt at pleaſure, blow up ſome drops firſt into one of the patient's noſtrils, and then into the other.

To prevent and check the apoplexy.

29. Make an iſſue at the meeting of the ſutures, and keep it long open; but if the caſe will not admit a delay, clap on a good cupping-glaſs, without ſcarrification, or with it, as need ſhall require, upon the ſame concourſe of the ſutures.

An experienced external remedy in apoplectic fits.

30. Fix a cupping-glaſs, without ſcarrification, to the nape of the neck, and another to each ſhoulder; and let them ſtick on for a competent time.

An experienced remedy to prevent apoplectic fits.

31. Make, at the croſſing of the ſutures, an iſſue, with diapalma and oil of vitriol; and keep it open the ordinary way.

To ſtrengthen the ſtomach, and promote the appetite.

Appetite improved.

32. Make the roots of gentian pulverable, with no more waſte of the moiſture than is neceſſary; reduce them to powder, of which let the patient take from twelve or fifteen grains, to double that quantity, or more, twice or thrice a day. It may be taken on an empty ſtomach, or, if that cannot conveniently be done, at meal-times. It is very good, not only in want of appetite, but for obſtructions: and I have uſually given it in vertiginous affections of the brain; and to leſſen, if not quite take away, the fits of agues, and even quartans: but, in this caſe, the doſe muſt be conſiderably augmented.

An often try'd remedy for the aſthma.

Aſthma.

33. Take ſoap-boilers lees one part, ſpirit of wine rectified two parts; ſet them in digeſtion, and add ſome drops of chymical oil of carraway, and of aniſeeds. The doſe in younger perſons is about ten drops; and in elder ones, from half a dram to one dram, in ſome convenient vehicle.

For a dry or convulſive aſthma.

34. Take choice ſaffron, reduced to a kind of powder; and with any convenient mixture, give eight or ten grains of it, in the form of pills, at bed-time.

For aſthmatic coughs.

35. Take two ounces of oil of ſweet almonds, freſh drawn, and put it upon one dram of flowers of brimſtone; keep them, for a fortnight, in digeſtion, in a moderate heat, and then decant off the oil, or paſs it through a clean linen rag, to keep back the brimſtone: and of this liquor give a ſpoonfull or two at a time.

A medicine for dry or convulſive aſthma's, and for coſtiveneſs.

36. Give, at bed-time, eight or ten grains of choice ſaffron, groſly pulverized, in a little ſyrup or conſerve of violets.

For moſt aſthmatic diſtempers.

37. Take of the roots of elecampane, thinly ſliced, one ounce; of the leaves of ground-ivy a handful. Boil theſe in three pints of ſpring-water to a quart; ſtrain the decoction, ſweeten it with a little live honey, and let the patient take thereof ſix or ſeven ſpoonsfull at a time.

For moſt aſthmatic diſtempers.

38. Take juice of hyſſop, and choice honey, of each two pound; mix, boil, ſcum, and make a ſyrup; of which give four ſpoonsfull, or more, morning, noon, and night.

For the bloody-flux.

Bloody-flux. 39. Dry pigs-dung, and burn it to grey aſhes; of which give about half a dram for a doſe; drinking three ſpoonsfull of wine-vinegar after it.

For the bloody-flux and pleuriſie.

40. Grate to fine powder the dry'd pizzle of a ſtag; and give of it as much as will lie upon a ſhilling, once or twice a day, in any convenient vehicle.

An experienced medicine for a dyſentery, or bloody flux.

41. Give about three ounces of the juice of ground-ivy, mixt with one ounce of the juice of plantain, once or twice a day.

To ſtop a dyſentery, or bloody-flux.

42. Make up the powder of fuſs-balls, with ſome conſerve of roſes, or other convenient ſubſtance, into pills; and of this mixture give as much in the dyſentery, as contains from about a ſcruple, to half a dram of the powder.

MEDICINE.

For dyſenterical fluxes.

43. Take good *Venice* turpentine, and, with a very gentle heat, evaporate it ſo far, that, when cold, it may almoſt coagulate. Incorporate this ſubſtance with fine ſugar, enough to make it up into pills, whereof give, in the morning faſting, as many as will amount from a ſcruple to a dram of the turpentine.

An experienced remedy for dyſenterical fluxes.

44. Take the thigh-bone of a man, calcine it to whiteneſs; and having purg'd the patient with an antimonial medicine, give him one dram of this powder for a doſe, in ſome good cordial.

For the dyſentery, and fluxes cauſed by ſharp humours.

45. Take from half a ſcruple to one ſcruple of *Mercurius dulcis*, and as much fine ſugar; and with ſome purgative, let the patient take it once a day; with care that none of it remain in his mouth or throat.

An often try'd medicine for fluxes of the belly, tho' bloody.

46. Give for a doſe, in any convenient vehicle, as much powder'd pizzle of a ſtag, as will lie upon an ordinary half-crown piece.

An effectual medicine for dyſenterical and other fluxes.

47. Take of the skin, liver, gall, and all the parts, except the muſcles, of a hare; and having dry'd them ſo, that they may be conveniently reduced to powder, give of it from about two ſcruples to one dram, in any convenient vehicle.

For a bloody-flux.

48. Take half an ounce of *London*-treacle, and an ounce of conſerve of red roſes; mix them together with ſome ſyrup of clove july-flowers, or of citrons, and keep them thus mix'd in a cover'd pot. Take of the electuary about the quantity of a walnut, night and morning, for two days, faſting two hours before and after; then intermit a day, and take it again in the like manner.

An often try'd remedy for the dyſentery, and ſharp fluxes of the belly.

49. Give from 15 to 20 grains of *Mercurius dulcis*, well prepar'd, and incorporated with about an ounce of catholicon, or one ſcruple of torrified rhubarb.

For the bloody-flux, or other fluxes.

50. Take of *Japan* earth, and powder of rhubarb, each equal parts; and give half a dram at a time, every morning, faſting.

An often try'd medicine for the bloody-flux, good alſo in pleuriſies.

51. Give one dram of the ſeed of flix-weed, in two or three ſpoonsfull of any convenient vehicle, once or twice a day.

An approved medicine for the bloody-flux, good alſo for pleuriſies.

52. Give two or three ſcruples of hare's blood, beaten to powder, for one doſe, in a ſpoonfull or two of mint-water.

A very often experienced remedy, for dyſenterie and other fluxes.

53. Boil the quantity of a walnut of the freſh warm dung of a hog, and as much fine mutton ſuet, ſliced thin, in a porringer of new milk: when theſe are well incorporated, ſtrain them through a clean linen cloth; ſweeten it with loaf-ſugar, and let the patient take the medicine warm, once or twice a day.

To purifie and ſweeten the blood.

Blood to purify. 54. Take the *Minera* of *Hungarian*, or other choice antimony, and having ground it to very fine powder, without ſuffering it to touch any metal, give of it from ten grains to a dram, once a day, at dinner, that it may mix with the aliment.

To cleanſe the blood, and ſtrengthen weak patients.

55. Take of vipers, reduc'd to fine powder, one ounce, diaphoretic antimony half an ounce, clear yellow amber two drams, ſtarch as much as all the reſt, and of ſugar as much as of ſtarch; make them into a fine paſte with ſpirit of wine, and then form them into ſmall cakes, whereof one may ſerve for a doſe.

To reſolve extravaſated blood.

Blood to reſolve, when extravaſated. 56. Spread the powder'd root of burdoc, upon a linen cloth, and bind it quite round the part affected; renewing it twice a day.

To ſtrengthen the bowels.

Bowels to ſtrengthen. 57. Let the patient, from time to time, ſwallow a clove of garlic or two, without chewing.

To reduce flaggy breaſts to a good ſhape and plumpneſs.

Breaſts, their diſorders to cure. 58. Take green hemloc well bruis'd, and reduced to a kind of cataplaſm, to be apply'd, gently warm'd, to the parts, and kept on till it hath performed what was intended; ſhifting it once a day.

For ulcers in the breaſt, or elſewhere.

59. Take millepedes, or wood-lice, and having waſh'd them clean, with a little white-wine, and dry'd them with a linen cloth, beat them

very well, in a glaſs or marble-mortar, and give, for the firſt time, as much juice, as you can, by ſtrong expreſſion, obtain from five or ſix of them. This juice may be taken in ſmall ale or white-wine, in which, the next time, you may give as much as can be ſqueez'd out of eight or nine millepedes; and ſo continue, increaſing the number that you employ by two or three at a time, till it amount to twenty-five or thirty; and, if need be, to forty or more, for one taking. And if, upon pounding of theſe inſects, the maſs they afford be too dry, you may dilute it with a little white-wine, or ale; that, being penetrated, and ſo ſoftned by the liquor, the maſs may the better part with its juice. Medic

An often try'd cataplaſm to break a ſore breaſt.

60. To the yolks of 4 eggs, take 4 ounces of live honey, mix them, by grinding, well together, with about half a pint of claret-wine; and apply this mixture, as a poultis, to the part affected.

For an outward bruiſe.

61. Apply to the part affected, purified honey, ſpread upon cap-paper; to be kept on, with ſome convenient plaiſter, or bandage, and ſhifted once or twice a day. *Bruiſes.*

Or,

62. Beat aloes ſuccotrina to fine powder; and pour on it as much roſe-water as may diſſolve a great part of it. This done, ſtir them well for a while; and when the mixture is ſettled, pour off the liquor, and in it dip linen-rags, which being applied to the part affected, will ſoon ſtick to it; and ſeldom need be removed, till the patient is reliev'd: and then, to get them off, the rags muſt be well wetted with warm water.

For a freſh bruiſe.

63. Take freſh butter and parſley, of each a ſufficient quantity, and having chopt the herb, mix it very well with the butter, to the conſiſtence of a cataplaſm; to be apply'd, warm, to the bruiſed part.

For a bruiſe, or coagulated blood.

64. Take black ſoft ſoap, and with a ſufficient quantity of crumbs of white-bread, very well mixt with it, make a paſte, which is to be laid on the part, with a linen rag, and kept bound upon it for ſome hours; that it may have time to reſolve the congeal'd blood, and bring the contuſed part from a livid to a red colour.

A powerful medicine for bruiſes, and ſeveral other affections.

65. Diſſolve in rectified ſpirit of wine, as much pure camphire as you eaſily can; and keep it very cloſe ſtopt. To uſe it, moiſten thoroughly ſome thin pieces of linen or flannel therewith, and apply them luke-

warm; and, likewiſe, you may, with a rag dipt therein, apply it to the eye-lids; taking care that none of it get into the eye itſelf, ſince there it would cauſe great ſmart. It may, alſo, be very uſefully apply'd to burns; and yet more ſo to bruiſes.

For burns.

Burns. 66. Take gooſe-greaſe, and having ſoftly melted, and a little ſkimm'd it, ſqueeze into it as much freſhly expreſt juice of ground-ivy-leaves, as, by continual ſtirring, will bring it to the conſiſtence of a green ointment. With this anoint the part affected, and afterwards lay on it fine old rags, well dipt in the ſame ointment.

For burns, and ſtanching of blood.

67. Diſſolve a large proportion of ſugar in rain-water; and with a ſufficient quantity of linſeed-oil, or oil of olives, beat up this liquor till the oil be brought to the conſiſtence of an unguent, with which anoint the part affected as ſoon as poſſible; renewing the application occaſionally.

A very often experienced remedy for burns.

68. Take two parts of oil of walnuts, and one of honey, mix them well together over a gentle fire, and when they are thoroughly incorporated, dip a feather in the mixture, and therewith anoint the part affected, ſo that the ointment may touch it immediately; and then ſtrew on it ſome powder of ceterach, or ſpleen-wort; keeping the part quiet, and defended from the air.

Againſt burns.

69. Beat onions into a ſoft maſs, and apply them, as ſpeedily as poſſible, to the part affected; and keep them on it till they begin to grow dryiſh; and then, if need be, ſhift them, and apply freſh.

For a freſh burn.

70. Beat a ſufficient quantity of onions, very well, with common ſalt finely powder'd, to be applied, as a cataplaſm, warm, to the part affected; renewing it, if need be, till the impreſſion of the fire be taken out.

An

An excellent ointment for burns and ſcalds.

71. Take of the inner rind of the elder-tree, and of freſh ſheep's-dung, without any adhering ſtraws or foulneſs, of each one handful; and with freſh butter, or oil, make thereof an ointment, to be applied as uſual in ſuch caſes.

An approved remedy for burns, eſpecially recent ones.

72. Take a ſufficient quantity of adders-tongue, and gently boil it in linſeed-oil, till the liquor be ſtrongly impregnated with the herb; then ſtrain it, and keep it ſtopt for uſe.

An excellent ointment for burns and ſcalds.

73. Take of *Saccharum Saturni* half a dram, of the ſharpeſt vinegar four ounces; make a ſolution of the former in the latter, and add, drop by drop, (often ſtirring, or ſhaking them together) as much oil of elder as will ſerve to reduce the mixture into the form of a liniment.

For a burn.

74. Mix lime-water with linſeed-oil, by beating them together with a ſpoon; and, with a feather, dreſs the burn ſeveral times a day.

For a burn or ſcald in the eye.

75. Take the mucilages of quince-ſeed, flea-wort, linſeed and fenugreek ſeed, of each one ſcruple; boil them very lightly in 4 ounces of betony-water; filter and apply it to the part.

An approved medicine for a cancer, not broken.

76. Take dulcify'd colcothar, and with cream, or the whites of eggs, beaten to a water, bring it to a cataplaſm; which ought to be made large, and ſpread about the thickneſs of half a crown, and applied warm to the part affected; ſhifting it, at leaſt, once a day. Canc

For a cancer in the breaſt.

77. Take of the warts that grow on the hinder legs of a ſtone-horſe, dry them gently till you can reduce them to a powder, of which you may give half a dram for a doſe in any convenient vehicle. And to reſolve hard tumours in womens breaſts, apply to the part turnips boiled, and made unctuous with freſh hog's lard.

A very often experienced medicine for cankers in the mouth, and elſewhere.

78. Take flowers of ſulphur one ounce, roch-alum, crude and finely pulveriz'd, half an ounce; mix theſe very well together, and incorporate them with as much good honey, as will ſerve to bring the mixture Cank

to the conſiſtence of a liniment, to be apply'd, from time to time, to the part affected.

A try'd medicine for chilblains.

Chilblains. 79. Take thick freſh parings of turnips, and hold them to the fire till they be very criſp; then apply them to the unbroken tumours or bliſters, as hot as the patient can endure; keep them on for a competent time, and apply new if need require. They will cauſe the peccant matter to tranſpire, or otherwiſe waſte, without breaking the bliſters.

A remedy for chilblains.

80. Take a turnip, roaſt it well under the embers, beat it to a poultis, apply it very hot to the part affected, and keep it on for 3 or 4 days; or ſhift it twice or thrice, if occaſion require.

For the chin-cough, and ſtuffing of the lungs.

Colds and coughs. 81. Make ſyrup of peny-royal, or of ground-ivy, moderately tart with oil of vitriol; and of this let the patient take, very leiſurely, about a quarter of a ſpoonfull from time to time.

For coughs, eſpecially ſuch as proceed from thin rheums.

82. Take of choice olibanum finely powder'd, from one ſcruple to half a dram, and mix with it an equal weight of ſugar-candy; let the patient take it at bed-time, in the pap of an apple, for ſeveral nights together: it may, alſo, be taken occaſionally, at any other time when the ſtomach is empty.

An approved remedy for a cold, eſpecially if it affects the breaſt.

83. Take a ſheet of brown paper, of an even texture, and anoint it uniformly over, and very well, with old tallow, ſo that the paper may be thoroughly penetrated by it: then cover it thinly with nutmeg, and clap it warm to the pit of the ſtomach, that it may reach far both above and beneath it.

An experienced medicine for coughs.

84. Boil good turnips in water, and having expreſs'd the juice, mix it with as much finely powder'd ſugar-candy, as will bring it into a kind of ſyrup; of which let the patient ſwallow a little, as gently as he can, from time to time.

A medicine, which cured a gentlewoman, who had, in vain, taken much phyſic for a conſumptive cough.

85. From ten or twelve fine raiſins of the ſun, take out the little kernels, and ſtuff the raiſins with the tops of rue; and let the patient ſwal-

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ſwallow them, either as they are, or in the form of a bolus, early in the morning; faſting after them for two or three hours at leaſt.

A powerful medicine to ripen coughs, and haſten the expectoration of phlegm.

86. Cut onions into ſlices, and fry them with freſh butter, as if you were to eat them; then boil them with new milk, till it be well impregnated therewith, and they be made tender. Of this mixture let the patient take a moderate quantity from time to time.

An excellent remedy for a cough.

87. Take of virgin-honey two ounces; of red roſes, warily dry'd, and finely powder'd, half an ounce; of choice ſulphur, very well ſifted, two drams; of good benjamin reduced to fine powder one dram; beat and mix all theſe very well; and let the patient take the quantity of a nutmeg thereof, from time to time.

For a cough, eſpecially if accompanied with a tickling rheum.

88. Take equal parts of finely powder'd olibanum, and *Venice*-treacle; incorporate them exactly, and of this maſs form pills of what bigneſs you pleaſe. Let the patient take about half a dram, at bed-time, or, if need be, one ſcruple, or more, twice a day.

An experienced balſam for coughs, conſumptions, old ſtrains, bruiſes, aches, &c.

89. To one part of good flower of brimſtone, put four or five, in weight, of oil-olive, and boil them together in a large earthen veſſel, till the ſulphur is perfectly diſſolved, with the oil, into a blood-red balſam; ſtirring it carefully all the time. When this is outwardly applied, it ſhould be well warmed and chafed into the part affected; or lint being dipt in it, may be kept upon the place. It may, alſo, be taken internally at any time when the ſtomach is not full, either roll'd up in ſugar, or mixed with any convenient vehicle, from two to fifteen or twenty drops. This remedy has proved ſerviceable in conſumptions, and, externally, in fits of the gout.

A remedy for the colic.

The colic.

90. In a draught of any convenient liquor, diſſolve about one dram of good ſalt of tartar; and let the patient take it for a doſe.

For the colic.

91. Take clean white chalk, dry'd, and reduced to fine powder; wet this with the expreſs'd juice of camomile, and let it dry in the air, without the heat either of the fire, or of the ſun. This done, wet it again with new juice of camomile, and dry it the ſecond time, as before. Wet and dry it again the third time, or even a fourth time; then again

reduce

MEDICINE. reduce the dry maſs to fine powder: and of this powder let the patient take at a time, as much as will lie upon a ſix-pence, in a proper vehicle.

For the colic and ſeveral other diſtempers.

92. Take 4 or 5 balls of freſh ſtone-horſe dung, and let them ſteep, for about a quarter of an hour, in a pint of white-wine, in a veſſel well ſtopp'd, that the liquor may be richly impregnated with the more volatile and ſubtile parts of the dung; ſtrain, and give of it from a quarter to half a pint, or more at a time; the patient having a care not to take cold after it.

An approved medicine for the colic.

93. Mix about half a dram of maſtic, with the yolk of a new laid egg; and give it to the patient once or twice a day.

An experienced medicine for the colic.

94. Take of good nitre one ounce, rub it well in a clean ſtone-mortar, with half a ſcruple, or more, of fine ſaffron; and of this mixture give about half a dram for a doſe, in three or four ounces of cold ſpring-water.

A mixture for fits of the colic, and ſome kinds of convulſions.

95. Take one ounce of flower of ſulphur, and as much ſugar-candy; grind them very well together in a ſtone mortar, and upon this quantity drop thirty drops of oil of carraway-ſeeds, as much oil of oranges, and as much of the oil of aniſeeds: incorporate theſe well, and of the mixture give about twenty or thirty grains for a doſe.

An incomparable medicine for the colic.

96. The yellow peel of oranges being reduced to powder, give from half a dram to two ſcruples of it, in any convenient vehicle.

An often experienced medicine for the colic, eſpecially if produced by ſharp humours.

97. To a quart of claret, put about two ounces of nettle-ſeeds; ſtop the bottle, and keep it in boiling water, a little, to aſſiſt the wine's impregnation with the finer part of the ſeeds: and of this liquor let the patient take a ſmall draught once or twice a day.

A good purging drink for the colic.

98. Take two ounces of rhubarb, four ounces of gentian, and a quart of good aniſeed-water; let the roots infuſe long in it, and give the patient about two ſpoonsfull at a time, as often as need requires.

A medicine almoſt ſpecific for a fit of the colic.

99. Take about half a dram of the expreſs'd oil of nutmegs, commonly called oil of mace; diſſolve it in ſome ſpoonsfull of good wine, which the patient is to take as hot as conveniently he can.

A try'd remedy for colics, good alſo in fits of the mother.

100. Take dry ginger, and cut it into thin ſlices; with theſe fill a pipe, and receive the ſmoke, as you would that of tobacco. Do this twice, thrice, or four times a day, but eſpecially at bed-time, and in the morning.

An excellent medicine for convulſive colics.

101. Take of the volatile ſalt of pigeons-dung two or three grains, or more; mix it with a ſcruple, or half a dram of the ſame dung crude, but ſlowly dry'd, and finely powder'd. Give this mixture for one doſe, in ſome ſpoonsfull of any convenient vehicle.

For the colic, or pains in the ſides.

102. Take two balls of freſh horſe-dung, and infuſe them for twelve hours in good white-wine, in a cloſe veſſel; then ſtrain the liquor, and let the patient take five or ſix ounces of it at a time.

For the colic.

103. Boil about one ounce of the ſeeds of black ſtinging nettles, in a quart, or more, of good claret-wine; ſtrain the decoction, and give of it a wine-glaſs full at a time, twice or thrice a day.

An excellent medicine for the colic.

104. Take of Dr. *Stephens*-water, plague-water, juniper-berry-water, of each half a pint, powder of rhubarb two ounces; mix theſe together, ſhake the bottle, and take about 4 ſpoonsfull at a time.

For the colic.

105. Give of orange-peel dry'd and powder'd, a ſpoonfull at a time, mixed, with a little white ſugar, in any convenient vehicle.

A good medicine in pains of the colic or ſtone.

106. Take half a pint of ſallad-oil, and as much ſack, or claret-wine; ſhake them very well together, and give them, moderately warm, for a glyſter.

An approved medicine for inveterate ſcorbutic colics, and pains of the bowels.

107. Take *Engliſh* barley, well waſh'd, and boil it in a ſufficient quantity of freſh ſpring-water till it be ready to burſt; then pour off the clear, upon the yellow part of the rinds of lemmons, freſh cut from the white, and put them into a bottle, carefully ſtopt, for conſtant drink.

To make lime-water uſeful in ſeveral diſtempers.

nſumptions. 108. Take one pound of good quick-lime, ſlake it in a gallon of warm water, and let it ſtand till all that will ſubſide be ſettled at the bottom, and after ſeparation, the water ſwim clear at the top; at which time, a kind of thin, brittle ſubſtance, like ice, will cover the ſurface of the liquor: as ſoon as the water is thus ſufficiently impregnated, pour it off warily, and keep it well ſtopped for uſe.

A lime-water for conſumptions and obſtructions.

109. In a gallon of cold lime-water, infuſe ſaſſafras, liquorice, and aniſeeds, of each 4 ounces, choice currants, or ſliced raiſins of the ſun, half a pound. The doſe is 4 or 5 ounces, to be taken twice a day.

A very nouriſhing aliment, that hath recovered many in conſumptions.

110. Boil eight or ten craw-fiſhes, after the blackeſt gut or ſtring is taken out, in barley-water, till they become very red; then take them out, and beat them long, ſhells and all, in a marble-mortar, and in a preſs, ſtrongly ſqueeze out the juice; which may be given either alone, or mixt with about an equal part of chicken-broth, or ſome ſuch convenient alimental liquor.

For convulſions, eſpecially in children.

nvulſions. 111. Take earth-worms, waſh them well in white-wine, but ſo as they may not die in it; then dry the worms, with a moderate heat, upon hollow tiles, that they may be conveniently reduced to powder; to one ounce of which add ſome grains of amber-greece. The doſe is, from one dram to a dram and half, in any convenient vehicle.

For convulſions in children.

112. Give the patient from 2, 3, or 4, to 5, 6, or 7 grains, according to the child's age, of the true volatile ſalt of amber, in any proper vehicle. But this medicine is not ſo efficacious in full grown perſons.

A remedy that has cured many children of convulſive fits.

113. Put two or three drops of chymical oil of roſemary, into half an ounce of ſack; ſtop the vial, and let it be well ſhaken, to make a whitiſh mixture of the liquors, juſt before you give it. Or elſe in a

half-

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half-pint vial, put 4 ounces of ſack, or ſome appropriated liquor, and drop into it forty drops of the forementioned oil; and whenever you are to exhibit the medicine, ſhake the vial, and preſently give of the whitiſh mixture a child's ſpoonfull.

A ſucceſsful medicine for convulſions, and hyſteric fits.

114. Hang the liver of a hare up in a dry place till it be dry, having a care that it putrefie not; of this, reduced to powder, let the patient take two or three ſcruples at a time, in any convenient vehicle.

An experienced remedy for convulſions, and the falling-ſickneſs in children.

115. Take from one ſcruple to two, or more, of fine prepared amber, and of native cinnabar ten grains; mix them, and this, ſweetned with ſugar, let the patient take twice a day, during ſix weeks, unleſs he fully recovers before. However, he is to take it for two or three days before each new and full moon, for ſome months ſucceſſively.

An often experienced medicine for convulſions, eſpecially in children.

116. Put a pound of the true ſingle piony-roots, ſcraped and ſliced as thin as paper, into three pints of white-wine; infuſe them all night on embers, in a pipkin cloſe cover'd; in the morning ſtrain it out hard, and put in a quarter of an ounce of powder'd caſtor, an ounce of the beſt ſpirit of caſtor, thirty grains of the moſs of a dead man's ſkull, and thirty grains of the ſkull it ſelf: put all theſe into a ſtrong glaſs, that is very dry, and ſhake them briſkly for half an hour. It may be given in the fit; a ſpoonfull to a young child; and to a man, or woman, a wine-glaſs full.

A medicine that has cured very many, eſpecially children, of convulſive fits.

117. Give of the powder of a ſound ſkull of a dead man, as much as will lie upon a groat, made up into a bolus, with conſerve of roſemary-flowers, to a child: but in grown perſons, the doſe muſt be augmented to double the quantity. The medicine ſhould be given often, if neceſſity requires. It may, alſo, be uſeful to apply to the throat a kind of necklace, made of the roots of vervain, cut into beads.

A plaiſter to prevent corns.

Corn

118. Take yellow bees-wax 4 ounces, verdigreaſe powder'd and ſifted one ounce, the *Caput mortuum* of human ſkull one dram; incorporate them well, by a little boiling, and make thereof a plaiſter.

An effectual plaiſter to ſoften and looſen corns.

119. Spread a plaiſter of crude gum ammoniacum, and applying it to the part affected, let it lie on as long as there is occaſion.

A powerful remedy for corns.

120. Evaporate the ſtrongly expreſs'd juice of radiſhes, to the conſiſtence of a ſoft plaiſter, to be applied to the part affected, and ſhifted as often as it grows dry. 'Twill ſmart for a while, at firſt, but afterwards 'twill do its work.

A good remedy for corns of the feet.

121. Spread the yeaſt of beer upon a linen rag, and apply it to the part affected, renewing it once a day.

A try'd medicine to take away corns.

122. The part being made ſoft by bathing, and ſcrap'd, apply to the corn a plaiſter of ſhoemaker's wax; but if the part be very tender, your plaiſter may conſiſt of equal parts of ſhoe-maker's wax, and diapalma, melted together, and ſpread thin.

An often try'd remedy for corns.

123. Mix up the juice of houſleek, with about equal parts of the thick yeſt that ſticks to beer-barrels, or to the clay that ſtops them. Of theſe make a kind of plaiſter, which being kept upon the toe for a while, and renewed, will make the corn very ſoft, and eaſie to be extirpated.

A try'd remedy for corns.

124. Take ſtrained ammoniacum, and diapalma, of each an ounce, *Arcanum corallinum* half an ounce, white precipitate two drams: mix them well together, and apply the plaiſter only over the corn, firſt cut as cloſe as is convenient.

An uſeful medicine for coſtiveneſs.

Coſtiveneſs. 125. Take virgin-honey a ſufficient quantity, and mix exactly with it as much finely powder'd *Cremor tartari*, as will bring it to the conſiſtence of a ſoft electuary; of which the patient may take, upon the point of a knife, the bigneſs of an almond.

An eaſy medicine for coſtiveneſs.

126. Take *Straſburg*-turpentine an ounce, and the yolk of an egg; grind them well together, and put thereto a pint of fat mutton-broth, and exhibit it, blood-warm, for a glyſter.

An innocent medicine for coſtiveneſs.

127. Boil in as much broth as will fill a large porringer, about half a handful of the leaves of common mallows, chopp'd; and of this broth ſtrained, let the patient make the firſt part of his meal.

For the cramp.

Cramp

128. Chop the leaves of roſemary very ſmall, and ſew them ſo in fine linen or ſarſnet, as to make a kind of garter of them, to be ty'd about the patient's bare leg.

To take off the pain of the cramp.

129. Take of the ointment of populeon two parts, oil of ſpike one part; mix them, and with the mixture chafe the part affected.

An amulet againſt the cramp.

130. With the root of mechoacan, in powder, fill a little bag of ſarſenet, about three inches ſquare; and hang it, by a ſtring, about the patient's neck, ſo that it may reach to the pit of the ſtomach, and touch the skin.

For incontinency of urine, or a beginning diabetes.

Diabetes

131. Having cut off the necks of blown ſheeps-bladders, put the remaining membranes, one over another, into a pot, where being cover'd and dry'd gently in a baker's oven, take them out, pulverize them well, and give as much as will lie upon a ſix-pence for a doſe.

An uſeful powder for ſuch as cannot hold their urine.

132. Take roots of the male piony, yellow amber, red coral, and gum arabic, of each a ſufficient quantity: reduce them to fine powder, mix them well, and let the patient take of this mixture from ten to twenty grains, twice a day.

A good medicine for the dropſy.

Dropſy

133. An ounce and half of ſliced mechoacan, being infuſed, for 24 hours, in a pint of white-wine, and the liquor drank of every morning for ſome days, is admirable in the dropſy; and if a little muſtard-ſeed be infuſed therein, it will be ſo much the better.

The Pilulæ Lunares, *excellent in the dropſy.*

134. Diſſolve any quantity of the beſt thoroughly refined ſilver, in ſpirit of nitre, or *Aqua fortis*, firſt cleanſed by ſilver; then evaporating away the ſuperfluous moiſture, let the reſt ſhoot into thin cryſtals; which being kept in a proper degree of heat, in a ſand-furnace, the greateſt part of the more looſe and fetid ſpirits of the menſtruum, will be driven away; yet the remaining cryſtals not be brought to flow. Let theſe cryſtals be counterpoized with their weight of cryſtals of nitre, and diſſolving each of them apart, in diſtilled rain-water, afterwards mix the ſolutions, and abſtract the ſuperfluous moiſture, till the remain-

ing maſs be dry; which you muſt keep expoſed to ſuch a temperate heat of ſand, that the matter may not melt; yet the adhering corroſive ſpirits of the menſtruum be driven away. To this end the maſs muſt be ſtirred, from time to time, till the remaining white powder yields no offenſive ſcent of the ſpirit of nitre, or *Aqua fortis.* Then, laſtly, with the crumb of white bread, made into a ſtiff paſte, form the powder into a maſs for pills, and preſerve it in a well ſtopp'd glaſs for uſe. The doſe is ſomewhat uncertain. 'Tis, therefore, adviſeable, to make the pills of the ſize of very ſmall peaſe; of which, one, given at bed-time, is ſufficient in ſome conſtitutions, tho' others require two; and there are thoſe who may take three. They ought to be gilt, or otherwiſe guarded from the tongue and palate, becauſe of their extreamly ſtrong and nauſeous bitterneſs. Where there are ſerous humours, one doſe of this pill will ſometimes work for 3 or 4 days ſucceſſively, yet moderately, and without much weakning the patient. If a continued uſe of them brings the patient to a leucophlegmatia, 'tis eaſily remedied by intermitting them for a while, and giving a little *Crocus Martis*, extract of juniper, or other aſtringents, to ſtrengthen the *Viſcera*, and preſerve their tone.

An often try'd medicine for an eryſipelas.

Eryſipelas. 135. In the blood of a hunted hare, whilſt 'tis yet warm, drench clean linen rags; dry them in the free air, and keep them dry: lay a large piece of linen, thus ſtained, upon the part affected, and either by binding, or otherwiſe, keep it from falling off, and renew it from day to day, if there be need. If it grow too ſtiff by long keeping, you may ſoften it with a little warm water.

An often tried external medicine for an eryſipelas.

136. Take the blood of a hare, and if you can have it freſh, anoint the part affected with it; otherwiſe apply on it a linen rag, that has throughly imbibed the freſh blood of that animal, and been dried in the air.

An experienced medicine for an eryſipelas.

137. The blood of almoſt any living creature, is found, by many experiments, to be a ſpecific againſt an eryſipelas, being often rubbed on the affected part; or a cloth dipt in the ſame being laid moiſt thereon.

For a ſlight excoriation.

Excoriations. 138. Melt mutton-ſuet, taken from about the kidneys, and freed from its ſuperfluous fibres, or ſtrings; and to about two ounces of this, add, by degrees, about ſixteen or eighteen drops of oil of turpentine; ſpread this mixture on a linen-cloth; and by binding, or otherwiſe, keep it upon the part affected.

For an excoriation, when the true cutis is affected.

139. Take ſelf-heal, and having pounded it very well in a marble, or glaſs mortar, apply it to the part affected; renewing it but ſeldom, and not without need.

For an excoriation, and preternatural tenderneſs of any part of the skin.

140. Spread *Unguentum diapompholigos*, thinly upon lint, to be apply'd to the part affected, and kept on by a bandage, or ſome ſticking plaiſter.

For a bruiſe in the eye.

141. Incorporate the crumb of white bread, with black ſoft ſoap, into a ſoft paſte; of which make a little cake, and apply it to the bruiſed part, the eye being firſt ſhut, ſo that it may lie on for ſome hours. But this ought to be uſed with caution.

Remedies diſorders i the eyes.

An excellent medicine for clammy humours of the eyes.

142. Let new milk ſtand till it hath got a little cream upon it; then let the patient, when he is in bed, take up, with his finger, a little of the cream, and ſhutting his eye-lids, beſmear them with it; having a care that very little, or none get into his eyes, becauſe it would make them ſmart: let the cream lie on till the next morning, and, in caſe the patient chance to wake in the night, he may, if he finds cauſe, lay on a little more, and waſh all off in the morning.

An often try'd medicine, to take off the pearl on the eye.

143. Take of the juice of celandine, and mix with it about an equal part of pure honey; and of this mixture employ a drop, or two, at a time; letting it fall upon the pearl, morning and evening.

For a blood-ſhot eye.

144. Take a rotten apple, and as many tops of wormwood as, being well beaten together with it, will make a maſs of the conſiſtence of a cataplaſm; warm this a little, and put a ſufficient quantity of it into a thin and clean linen rag, and let the patient keep it upon the part affected all night; the next morning waſh it off with ſome red roſe-water, or the like liquor.

An ophthalmic water to preſerve the eyes and ſight.

145. Take of the diſtill'd waters of rue, celandine, and vervain, of each one ounce; mix them, and infuſe in them, for ten days, two

drams of *Crocus metallorum*, exquiſitely ground, then very carefully filter the infuſion; of which let fall into the eye a drop or two, morning and evening; having a care not to ſhake the glaſs when you employ the liquor, leſt ſome unheeded duſt may have eſcaped the filter.

For a ſlight ophthalmia, or blood-ſhot eye.

146. Shake half a dram of prepared tutty into an ounce of red-roſe-water, and drop of it often into the eye.

For an ophthalmia, or blood-ſhot eye.

147. Take of the juice of houſleek two parts, that of daiſies and ground-ivy, of each one part; mix theſe juices together, and to about two ſpoonsfull of the mixture, put five or ſix drops of clarified honey: let the juices depurate themſelves by reſidence; and then, in ſome ſmall ſilver veſſel, clarifie them; and of this mixture let fall a drop or two into the eye, three or four times a day.

An experienced eye-water, for an inflammation and tumour of the eye.

148. Take of prepared tutty half an ounce, the water of white roſes, and of frogs-ſpawn, and alſo of the beſt canary wine, of each two ounces, of *Aqua mirabilis* half an ounce: mix theſe well, and drop a very little at a time into the patient's eye.

An experienced water for ſharp and ſlimy humours in the eyes and eye-lids.

149. Take of prepared tutty half an ounce, prepared coral and pearl of each half a ſcruple, *Trochiſci albi Rhaſis* five or ſix grains, red roſe-water, and ſuccory-water, of each an ounce and half; mix them well: and if you will have the medicine ſtronger, you may add three or four grains of aloes to it.

For a light ſtroke, or bruiſe on the eye.

150. Take two ounces of betony water, and three drops of clarified honey; mix them well together, and drop them into the eye, three or four times a day. The compoſition muſt be made freſh every ſecond or third day.

A powerful medicine for things growing on the eye.

151. Take white paper, and let it flame away upon a clean pewter plate, till there remain ſo much oil behind, as you think you ſhall need; blow off the aſhes of the paper, and a little ſpittle being mixt, by the finger, with the oil, make a kind of ointment; which being taken up with a feather, is to be apply'd once or twice a day, as the patient can bear the ſmart, to the affected eye: and this courſe is to be continued, till the cure be compleated.

For hurts that make a ſolution of continuity in the eye.

152. To two ounces of celandine water, put three or four drops of good clarified honey; and with this dreſs the eye at leaſt twice a day. But the mixture muſt be made freſh once in two or three days, or elſe it will grow ſouriſh.

An often try'd eye-water, eſpecially for outward diſorders of the eye.

153. Take of plantain-leaves 4 ounces, of ſtrawberry-leaves as much; bruiſe and digeſt theſe for 24 hours in a pint of good white-wine: then diſtil them to dryneſs in a glaſs-head and body, *in Balneo Mariæ.* The liquor that is thus obtained, put into a very clean braſs veſſel, and let it ſtand there for ſome hours, till it have acquired a manifeſt blue tincture; then put to it an equal weight of white roſe-water: ſhake theſe together, and let fall one drop into the internal corner of the eye; the patient bending backward, and ſhutting his eye-lids for a minute or two, that the water may diſperſe on the eye.

An uſeful medicine for pain or itching in the eye-lids, or in the eyes.

154. Boil half a ſpoonful of cleanſed *French* barley, for a little while, in a pint of ſpring-water, ſeaſonably putting to it a pugil of dry'd damask roſe-leaves. Foment the part, for a pretty while, with a ſoft ſpunge dipt in this liquor, morning and night; having a care that it be applied warm, at leaſt.

An excellent eye-water for redneſs and light films in the eye.

155. Make ſome lime-water, by pouring a gallon of ſcalding hot water upon a pound, or ſomewhat more, of quick-lime; ſtir them together, and after ſome hours, decant that which is clear. To a pound of this water, put half an ounce of choice verdigreaſe pulverized; and, in a very moderate heat, extract a tincture of a fine, light ſapphirine colour. Decant this very warily, and let a drop or two of it, at a time, fall into the eye, as often as need requires.

To ſtop a violent defluxion on the eye.

156. Take red ſage and rue, of each one handful, a ſpoonful of fine wheat-flower, and the white of a new-laid egg, beaten to water; mix theſe well, and ſpread them upon very thin leather, or black ſilk, and apply it to the temples.

For red eyes, from a defluxion of a hot or ſharp humour.

157. Take the tops of roſemary one dram, and beat them up with one or two ounces of rotten pearmains, or pippins: and when, by ex-

quiſite beating, you have reduced theſe to a cataplaſm, apply it warm to the part affected, binding it thereon, and letting it lie all night.

An eye-water.

158. Beat houſe-ſnails in their ſhells, and add to them about an equal quantity of juice of celandine; draw off the water in a cold ſtill, and keep what will come over, cloſe ſtopp'd for uſe.

The lady Fitz-Harding's *eye-water, which cured a perſon almoſt blind, whoſe eyes looked like glaſs.*

159. Take of white roſe-water, and eye-bright-water, of each three ſpoonsfull; as much ſifted white ſugar-candy as will lie on a threepence, and the ſame quantity of fine aloes ſifted; ſhake all together, and let fall a few drops into the eye, every night, going to bed.

A wriſt-plaiſter, that often cures flying clouds in the eyes, and ſometimes leſſer ſpecks.

160. Take of rue, camomile, and hemloc, each half a handful; of bay-ſalt two ſpoonsfull, and one or two ounces of leaven; incorporate theſe well together, and apply it to the patient's wriſts, to be kept on till it grow dry.

For hot defluxions on the eyes.

161. Take of prepared tutty half an ounce, white roſe-water, and frogs ſpawn-water, of each two ounces, *Aqua Mirabilis* half an ounce; mix theſe well together, and let fall two or three drops into the patient's eyes, eſpecially at bed-time.

An uſeful eye-water, to keep the eyes cool and moderately dry.

162. Take two ounces of ſuccory-water, half a dram of prepared tutty; ſhake them well, and keep them together for uſe.

An often try'd wriſt-plaiſter, for defluxions on the eyes.

163. Take rue, camomile, hemloc, and wormwood, of each half a handful, bay-ſalt pulveriz'd two ſpoonsfull, ſour dough an ounce; mix all theſe together, moiſtning them from time to time with elder-vinegar, to a proper conſiſtence; and apply it to the wriſt of that ſide on which the part is affected; renewing it if there be occaſion.

For a little tumour in the carneous tunicles of the eyes.

164. Dreſs the eye, from time to time, with the decoction of mucilages, to ripen the tumour; then open it with a lancet, and ſqueeze out all the matter; and, laſtly, cleanſe and heal the part with honey. But when the tumour is beginning, you may, in want of the decoction

of mucilages, dreſs the eye with a mixture of equal parts of the waters of melilot, camomile, and betony.

A plaiſter to ſtrengthen the eyes, and ſtop defluxions on them.

165. Take of frankincenſe two drams, olibanum and maſtic, each half a dram; mix theſe, and reduce them into fine powder, of which a convenient quantity is to be melted and ſpread upon black ribbon, and applied to the temples.

An often experienced medicine for little ſtrokes, or bruiſes on the eye.

166. Take betony water three ounces, and five drops of clarified honey; mix them, and drop a little of the mixture, from time to time, into the patient's eye.

An electuary to ſtrengthen the ſight.

167. Take conſerve of borage and betony, of each an ounce and half, *Venice*-treacle two drams, *Species Dianiſi*, *Diarrhodon Abbatis*, *Diatrion Santalon*, of each half a dram, tartar vitriolate a ſcruple, *Diacorallion* a dram and half, oil of fennel ſeven drops, ſyrup of violets and of coral, of each a ſufficient quantity; mix and make an electuary, to be taken the bigneſs of a nutmeg twice a day.

For an Opthalmia Sicca.

168. Take of the leaves of fennel, hyſſop, celandine, betony, and carduus, of each half a handful; of linſeed, quince-ſeeds, fenugreek, and flea-wort ſeeds, of each half a dram, of *French* barley one ounce: boil all theſe a little, in two quarts of fair water, and half a pint of white-wine: and let the patient hold his head (well fitted with a napkin for the purpoſe) over the fumes, for about a quarter of an hour.

For a film in the eye.

169. Take of roch-alum two parts, turmeric one part, and refined ſugar three parts; pulverize each of theſe ſeparately, then mix them exactly, and warily blow it into the patient's eye, from time to time, as need ſhall require.

A famous eye-water.

170. Take celandine, the whole plant except the root, and having ſhred it a little, put it into a retort, and diſtil it *in balneo*. When all the liquor is come over, empty the veſſel, and put it back upon as much more of the freſh plant, and diſtil a liquor, to be poured once more upon freſh celandine as before; and keep this laſt water cloſe ſtopt. 'Tis to be outwardly us'd, by three or four drops at a time.

A medicine for hurts in the eye.

171. Take ſuccory-water, and crumbs of white-bread, enough to bring it to a due conſiſtence; then add a little ſaffron; ſometimes, alſo, you may put to it a little honey, to make it more cleanſing and healing. Apply it, with pledgets of flax, to the part affected.

A good water for eyes that are foul, and pained by ſharp humours.

172. Take prepared pearl, and coral, of each one ſcruple; aloes caballina, finely powder'd, three grains, red roſe-water, and ſuccory-water, of each one ounce; mix them well; and if you would have the mixture ſtronger, put in a few grains of *Trochiſci albi Rhaſis* in very fine powder.

An experienced medicine for ſtrengthening a weak ſight.

173. Take of eye-bright, ſweet fennel-ſeeds, and fine ſugar, all reduced to powder, of each an ounce, nutmeg, alſo pulveriz'd, one dram; mix theſe very well together, and take of the compoſition, from one dram, to two or more, from time to time.

To take off little pimples, or inequalities, within the eye-lids.

174. Take eye-bright-water, plantain-water, of each a ſpoonfull, and half a ſpoonfull of red roſe-water; mix theſe, and put to them about 15 grains of prepared tutty; ſhake them together, and let the powder fall to the bottom; and, with the clear liquor, moiſten the eye ſeveral times in a day.

To ſtrengthen a weak ſight.

175. Take eye-bright, peny-royal, rue, celandine, lovage, ſaxifrage, of each half a handful, blue-bottle flowers, fennel-ſeeds, parſley-ſeeds, of each half a dram, grains of paradiſe one dram, hyſſop, organy, willow-leaves, each half an ounce, galingal three drams, ginger half a dram, cinnamon one dram, ſugar half an ounce. Let them be finely powder'd, and very well mixt together. Take of this powder one ſcruple, or half a dram, every day with your dinner.

To ſtrengthen the ſight.

176. Take roſemary-flowers, ſage, betony, rue, and ſuccory, of each one handful; infuſe theſe in two quarts of good ſack, and diſtil them in a copper alembic. The doſe is a moderate ſpoonfull.

To ſtrengthen the ſight.

177. Take powder of eye-bright one ounce, ordinary fennel-ſeed, in powder, half an ounce, powder of nutmeg half a quarter of an ounce, double refined ſugar two ounces. All theſe, being finely powder'd,

are to be mixt together, and taken as much as will lie on a ſhilling at a time, as often as you pleaſe. The powder is to be kept in a box, cloſe ſhut, in ſome dry place. This has perform'd great cures in dimneſs of ſight, and rheums in the eyes.

A medicine ſeveral times uſed, for a light ſtroke, or contuſion of the eye.

178. Put to two ounces of carduus-water, or that of betony, three or four drops of honey; uſe it every three hours. But keep it not above a day or two, leſt it grow ſour.

A drink, to be taken like tea, for ſtrengthening the ſight.

179. To a quart of water ready to boil, put half a handful of eye-bright; and let the liquor boil a very little before you take it off.

A water to ſtrengthen the ſight.

180. Diſtil clary in a cold ſtill; and of the water let the patient take every morning, and, if need be, every night, going to bed, from two or three ſpoonsfull to ſix, either alone, or ſweetned with a little ſugar; let him, alſo, with the ſame water, unſweeten'd, bathe or waſh the parts affected, in the morning, and at bed-time, or oftener.

An excellent water to preſerve the ſight.

181. To half an ounce of celandine-water, and two drams of ſuccory-water, put two or three drops of clarified honey, and ſhake them together when you uſe them. Of this water let fall a drop or two into the eye, once or twice a day. It will not keep above three or four days, eſpecially in ſummer, and, therefore, muſt be often renewed.

An often experienced medicine for blood-ſhot eyes.

182. Cut a new laid egg, boil'd hard, into halfs, and apply one of theſe, conſiderably warm, to the part affected, and keep it on for ſome hours. To the ſame purpoſe you may apply a poultis made of a rotten apple; the cold being firſt quite taken off.

A medicine for blood ſhot, or inflamed eyes.

183. Bathe the eyes ſeveral times every day, with a waſh made of frogs-ſpawn-water a pint, and ſalt of tartar a dram.

An excellent remedy for an inflammation in the eyes.

184. From an apple, cut into halfs, take out all the core, fill up the cavities with the tender tops of common wormwood, tye the halves together, and roaſt the apple well: then beat it, with the herb, to a kind of poultis, apply it warm to the part affected, and bind it thereon; letting it lie all night, or, if you uſe it in the day-time, for 6 or 8 hours.

An

An uſeful remedy for redneſs of the eyes.

185. Take a blanch'd almond, and three grains of camphire, and in a marble mortar, incorporate them by grinding; then add, little by little, two or three ounces of red roſe-water; ſtill grinding them till the whole be brought to a kind of emulſion. Drop a little of this into the part affected.

A medicine for redneſs of the eyes.

186. If the redneſs be attended with a fiery hot rheum, waſh the eyes, twice or thrice a day, with brandy.

For a ſlight inflammation of the eyes, or a hordeum *growing on the eye-lid.*

187. Take freſh houſleek; beat it to a kind of cataplaſm, and lay as much as is needful of it in the fold of a linen-rag, to be ſo apply'd, that the cataplaſm may reach the eye, and the reſt of the cloth be faſten'd about the patient's head. Let the medicine lie on all night, and be taken off the next morning. Repeat this application two or three times occaſionally.

For a ſlight redneſs of the eyes.

188. Take of *French* barley half an ounce, and of damask roſes half a handful; boil them, a very little, in a pint of ſpring-water; and with this moiſten the part affected.

For a ſlight redneſs of the eyes.

189. Take frog-ſpawn-water a pint, common ſpirit of wine 4 ounces; mix them: waſh the eyes therewith, five or ſix times a day; and at bed-time apply over them a cataplaſm of a rotten apple.

An uſeful medicine to prevent dryneſs, and ſome other diſorders of the eyes.

190. Take of choice virgin-honey two ſpoonsfull, of ſuccory-water, and the diſtilled water of eye-bright, each 4 ſpoonsfull; mix them, and in a very clean veſſel, over a very gentle fire, let them evaporate, taking the ſcum off from time to time, till the mixture comes to the conſiſtence of a ſyrup; keep this in a glaſs well ſtopp'd, and uſe it by letting fall a drop or two, at a time, into the eye.

A medicine to prevent running of the eyes.

191. In half a pint of white-wine, diſſolve two drams of white vitriol; filter it, and add choice honey two ounces: with this bathe the eyes two or three times a day.

The

The vitriolate eye-water.

192. Put 4 grains of *Roman* vitriol, to 4 ounces of the diſtilled water, either of roſes, ſuccory, fennel, &c.

For a light ſtroke, or bruiſe on the eye.

193. Into half an ounce of celandine water, ſhake three or four drops of clarified honey; and let fall of this into the eye a drop or two, twice or thrice a day.

For a ſtroke, or bruiſe in the eye.

194. Take of betony water, and hyſſop water, of each one ounce; herein ſtir ſome blades of ſaffron, till the liquor be pretty well colour'd; and laſtly, add to it 4 or 5 drops of clarified honey.

For a ſtroke, or bruiſe on the eye.

195. Take celandine water three ounces, ſpirit of ſaffron one ounce; mix them, and waſh the eyes therewith ſeveral times a day; and if they be very ſore, red, or blood-ſhot, after waſhing anoint them every time with a little pure virgin-honey.

To take off films, or the like, from the eyes.

196. Take choice bole-armeniac, in very fine powder; and blow it gently into the eye, once or twice a day. But if the patient be ſubject to ſwelling, heat, or diſaffection in the eye-lids, incorporate the powder with a little clarified honey.

To take off films from the eyes.

197. Take prepared coral one ounce, of pearls three drams, crabs-eyes one dram, virgin-honey two ounces; mix them, and anoint the eyes therewith 4 or 5 times a day, but chiefly morning and evening.

To ſtrengthen weak eyes ſubject to rheums.

198. Take *Lapis Calaminaris* four ounces, roſe-water a pint; ſhake them well together: then let it ſettle; pour off the clear water into a vial, and drop of it into weak eyes two or three times a day.

An experienced remedy for ſharp and hot humours in the eyes.

199. Into a quart of new milk, as it is boiling, put about two hands-full of green houſleek, freſh gather'd, and chopt ſmall, and let the milk boil on, till it will yield no more curd: then ſtrain the green poſſet-drink, and let the patient take once or twice, every day, a pint, ſweetned with fine ſugar. The drink may beſt be taken cold.

An excellent fumigation for pains in the eyes, too great dryneſs of them, and when a beginning cataract is apprehended

200. Take of fennel, hyſſop, betony, celandine, carduus, of each half a handful, linſeed, quince-ſeed, fenugreek, and fleawort-ſeed, of each half a dram, of *French* barley one ounce: boil theſe in two quarts of fair water, and half a pint of white-wine; and let the patient hold his head over the fumes of them, taken off the fire, for about a quarter of an hour every morning.

For ſore eyes.

201. Take the crumb of white-bread, half an ounce, coral, pearl and tutty prepar'd, and white ſugar-candy, of each half a dram; powder of red-roſes a dram and half, flowers of St. *John*'s-wort one dram; and with a ſufficient quantity of milk, make a cataplaſm, to be ſpread upon linen, and bound over the eye.

For heavineſs, and pain in the eyes.

202. Take flowers of melilot, elder, and of marigolds, of each a ſmall handful, linſeed, ſeeds of fenugreek, fleawort, cummin, and quinces, of each half a ſcruple, *French* barley half an ounce, damask roſes half an ounce, ſpring-water a pint and an half; mix and make a decoction, with which foment the forehead, temples, and eye-brows, warm.

For a dry inflammation in the eyes.

203. Take of betony, hyſſop, rue, wormwood, vervain, ſage-flowers, and roſemary-flowers, of each half a handful; the ſeeds of cummin, fennel, and carduus, of each a quarter of an ounce; boil theſe, a little, in two or three quarts of fair water, and let the patient hold his head, for about a quarter of an hour, over the ſteam of the decoction; uſing a napkin to keep the ſmoak from diſſipating, and to direct it to his eyes.

A famous eye-water.

204. Take two or three ounces of the water of pimpernel, diſtill'd *in balneo*, put this into a little porringer of roſe-copper; and add about the bigneſs of a filbert, of ſtrong quicklime: cover the veſſel, and let the ingredients lie in it till the liquor hath acquir'd a bluiſh colour. Then very warily pour off the clear, and add to it as much live honey, as will give it a little taſte: uſe it after the uſual manner of ſuch waters; and if it be too ſtrong, dilute it a little with water of the ſame plant, or good ſpring-water.

A famous eye-water.

205. Take red roſe-water a quart, aloes in fine powder, half an ounce, white vitriol, *Vitrum Antimonii*, *Crocus metallorum*, of each ſix drams; mix and digeſt, warm, for a month: then uſe the clear liquor 3 or 4 times a day: it has ſcarcely an equal.

An eye-water.

206. Take red roſe-water, plantain-water, of each an ounce; tutty prepared, half a ſcruple; *Lapis Lazuli* prepared, 6 grains; red coral prepared, 5 grains; mix, and make an eye-water. This dropped into the eyes, being firſt well ſhaken, cures inflammations of them, provided there be no great foulneſs, or ſcrophulous diſpoſition in the patient. It takes off the redneſs of the eye-lids, if with a ſponge dipt in it, they be often wetted: it alſo takes off films very well.

To clear the eyes from films.

207. Take human dung, of a good colour and conſiſtence, dry it ſlowly till it be pulverable; then reduce it into an impalpable powder, which is to be blown once, twice, or thrice a day, as occaſion ſhall require, into the patient's eyes.

To allay heat in the eyes, proceeding from ſharp humours.

208. Beat the white of en egg into a water, in which diſſolve a conſiderable quantity of refined loaf-ſugar; and then drop ſome of it into the patient's eyes.

For a ſlight ſtroke, or bruiſe on the eye.

209. Take two ſpoonsfull of fennel-water, or of betony-water, and let fall into it 4 or 5 drops at moſt, of good clarify'd honey: ſhake them well together, and uſe them twice or thrice a day. But you muſt have a care to make this mixture freſh once in 4 or 5 days, eſpecially in ſummer: for if it be much longer kept, 'twill grow ſour.

An excellent eye-water, to preſerve them from rheums, eſpecially ſharp ones.

210. From two parts of celandine, and one of eye-bright, diſtil *in balneo* a water, which put upon pulver'z'd *Lapis Calaminaris*, and let them digeſt together, in an exactly clos'd veſſel, for ſome weeks; adding, before you uſe it, a third part of brandy.

For the falling-ſickneſs in children.

211. Give half a dram of choice amber, finely powder'd, for ſix or ſeven weeks together, once a day, when the ſtomach is empty, in about 4 ounces of good white-wine.

Againſt the falling-ſickneſs.

212. Take of the powder of true miſſeltoe of the oak, as much as will lye upon a ſix-pence, early in the morning, in black-cherry-water, for ſome days, near the full moon.

To appeaſe the heat of fevers by an external remedy.

Fevers. 213. Apply to the ſoles of the feet a mixture, or thin cataplaſm, made of *Virginia* tobacco, beaten up with as many freſh currants, as will bring it to a poultis.

An excellent drink in fevers, tho' malignant.

214. To a quart of boiling ſpring-water, put one ounce of hartſhorn calcin'd to perfect whiteneſs; and when the mixture is cold, add three ounces of ſyrup of the juice of lemmons: when you wou'd uſe it, ſhake it well, and let the patient take a moderate draught, ſeveral times in the day and night.

An uſeful drink in feveriſh diſtempers.

215. In a pint and half of clear poſſet-drink, boil about one ounce of the cleans'd roots of dandelion, ſliced ſmall, till near half a pint be waſted; then ſtrain it, and let the patient take half a pint, or the whole quantity, if he can, at a time.

A good drink in continual fevers.

216. Boil the leaves of rue in fair water, till the liquor taſte pretty ſtrong of the plant: this being ſtrained, is to be made palatable with liquorice, or a little ſugar; and to half a pint of it, add about ten drops of ſpirit of vitriol; and let the patient uſe it for ordinary drink.

A good drink to be frequently uſed in fevers, eſpecially continual ones.

217. Give in half a pint of ſome ſmall convenient drink, half an ounce of hartſhorn, burnt to a great whiteneſs, and a little boiled in the liquor; and this is to be taken from time to time.

Sir Walter Raleigh*'s cordial; an approved and moſt excellent remedy for fevers, fluxes, or any caſe where diaphoretics, antidotes, and cordials, are proper.*

218. Take the dry'd flowers of borage, roſemary, marigolds, red july-flowers, *Roſa ſolis*, and elder-flowers, of each two quarts, of dry'd

ſcordium, carduus, angelica, baulm, mint, marjoram, ſetwall, betony, of each 4 handsful; the barks of ſaſſafras, and lignum aloes, of each four ounces, in powder; of kermes, cubebs, cardamoms, and zedoary, of each an ounce; ſaffron half an ounce, juniper-berries, tormentil roots, round birthwort roots, of each an ounce, and gentian root half an ounce. Draw the tincture of all theſe with ſpirit of wine *in balneo*, and afterwards calcine the ingredients, and put the fix'd ſalt they afford to the tincture. To ſix ounces of the extract of all theſe, with their ſalt, put three ounces of the magiſtery of coral, *Terra ſigillata* four ounces, prepared pearl two ounces, bezoar-ſtone three drams, calcined hartſhorn four ounces, ambergreaſe four drams, musk thirty grains, powder'd ſugar-candy one pound and a half, wherewith the perfumes being ground, add the dry ingredients thereto, and reduce them to a fine powder; then grind the tincture and dry things together, adding ſyrup of lemmons, and of red roſes, equal parts occaſionally.

Medici

To make the magiſtery of coral for this cordial, put eight ounces of whole coral, into an open calcining pot, and let it ſtand for 24 hours, in a calcining furnace, till the coral be white as ſnow; then put it into three quarts of diſtilled vinegar, in a bolt-head; into the neck whereof invert another, and ſet them in a ſand-furnace, up to the vinegar. Let it boil, without intermiſſion, for 24 hours, by which time the vinegar will become red; and, when cold, pour it off into a bell-glaſs; exhale away the moiſture *in balneo*, and reſerve the coral, perfectly dry, for uſe.

The doſe for a man is about the bigneſs of a ſmall hazel nut; if by way of prevention, the magnitude of an ordinary pea may ſuffice; but in urgent caſes the doſe may be increaſed to the quantity of a nutmeg.

A water for a fiſtula, all manner of wounds, ſwellings, old ulcers, cankers, tettars, boils, ſcabbs, or green wounds.

219. Take of bole-armeniac, and white vitriol, each 4 ounces; of camphire one ounce; boil the two latter together in an earthen veſſel, till they become thin, and ſtir them till they afterwards grow hard in cooling; then powder them in a mortar, and mix them with the bole-armeniac in powder, and keep the whole in a bladder for uſe. Into two quarts of boiling water, taken off the fire, put three large ſpoonsfull of this powder; and afterwards put them up into a glaſs, and ſhake it twice a day: but before 'tis uſed, let it be well ſettled, and very clear. Dip a ſoft, pliable tent herein, and apply it as hot as the patient can bear it, laying a clean linen cloth over the dreſſing four double, firſt moiſten'd in this water, and bind it on with a roller: continue to do thus every morning and evening. The water may be put into an oyſter-ſhell, when the ſore is dreſs'd, for pewter will ſuck it up.

Fiſtula

To appeaſe the fits of a Furor Uterinus.

Furor uterinus.

220. Burn the feathers of partridges, for a competent time, under the patient's noſe.

A try'd medicine for the falling down of the fundament.

Falling of the fundament.

221. Put ſome ſliced ginger in a little pan, heat it by clear and well-kindled coals, and let the patient receive the fume of it, caſt on by degrees, in a proper ſeat, where the lower part of the body may be well cover'd, for about half a quarter of an hour at a time.

For a ſlight gangrene.

Gangrenes.

222. After having lightly ſcarrified the part, apply, as hot as the patient can well bear it, a cataplaſm made of ſtrong brandy, and the crumb of white-bread; ſhifting it 3 or 4 times a day, or oftener, if need be.

To prevent a gangrene upon a great pain, and to ſtrengthen the part.

223. Take of melilot-plaiſter, and diapalma, equal parts; and having melted, and well incorporated them together, make thereof a thin plaiſter, which, being prickt full of holes, is to be laid upon the inflamed, or bruiſed part, firſt lightly ſcarify'd.

An experienced medicine for a gonorrhœa.

Gonorrhea.

224. Infuſe two ounces of ripe laurel-berries, for a day, in a quart of good white-wine; and of this let the patient drink about two or three ſpoonsfull, twice a day, for a pretty while together; omitting it once in three days, that he may take ſome gentle purging medicine.

For a gonorrhœa.

225. Swallow about half a dram of choice maſtic, in powder, put into the yolk of a new laid egg; waſhing it down, if it be thought needful, with any convenient liquor.

For the gonorrhœa.

226. Take equal parts of choice amber, and of maſtic, both in fine powder, mix them, and of this mixture give half a dram at a time in a proper vehicle, or in a draught of chocolate: continue it for three weeks, or a month, if need require; purging the day before you begin to take it, and once every week afterwards, eſpecially when you leave off the uſe of the powder.

For a gonorrhœa.

227. Take equal parts of choice red coral, and of maſtic, reduce them ſeparately to fine powder; mix them very well, and give about 30 or 40 grains for one doſe.

An often experienced remedy to expel gravel, and provoke ſuppreſt urine.

228. Take the thick membrane that lines the gizzard of a cock or hen, and having wip'd it clean, dry it ſo, that it may be beaten to powder: with this mix an equal part of choice red coral calcin'd, and of the mixture give from 20 or 30, to 40 or 50 grains.

An experienced remedy to expel gravel, and provoke urine.

229. Take the juice of onions two ſpoonsfull, white-wine half a pint; mix them for a draught. It gives preſent eaſe; and, if repeated for ſome time, ſoon cures.

To drive away gravel and ſmall ſtones.

230. Take the thick skin, found in the gizzard of a cock or hen, and having warily dryed it, till it be pulverable; give from a ſcruple to two ſcruples of it, in a draught of any convenient vehicle.

To take off the pains of the gout.

231. Take red-lead, ground fine, half a pound, oil of earth-worms one pound; boil them to the conſiſtence of a hard plaiſter, without burning: afterwards add of camphire two ounces, diſſolved in oil of earth-worms, and make a plaiſter of a juſt conſiſtence.

An excellent ointment in the gout.

232. Take *Barbadoes*-tar, and palm-oyl, of each a like quantity, melt them gently together; and with the mixture warm, let the part be anointed, and warily chafed.

An effectual medicine for gouty pains.

233. Beat linſeed, with a little water, in a marble mortar; rubbing it very well, that the medullary part being ſeparated from the husk, may make the water conſiderably white. In this liquor, clean rags being thoroughly wetted, apply them, ſomewhat warm, to the part affected, ſhifting them, if need be, once in an hour or two.

A ſpeedy remedy to take off gouty pains.

234. With a feather, dipt in good ſpirit of ſal-armoniac, moiſten, gently, all the parts affected.

A

MEDICINE.

A medicine that ſoon appeaſes the pains of the gout.

235. Take of black ſoap 4 ounces, choice wood-ſoot, finely ſifted, a dram and half, and half the yolk of an egg: incorporate them together, and, ſpreading the mixture ſomewhat thin, apply it warm, by way of cataplaſm, to the part affected.

An often try'd medicine to appeaſe the pains of ſcorbutic running gouts.

236. Having fill'd an earthen pot with cleans'd earth-worms, and luted on a cover, ſet it into an oven, with a batch of bread, and let it ſtand there till the oven be cold. Then take out the pot, and having remov'd the cover, you will find the matter turn'd into a groſs ill-ſcented liquor. Strain this by expreſſion, and keep it ſtopt, to rub therewith the part affected, with a warm hand, once or twice a day. If the ſmell be offenſive, you may put to it a few drops of oil of rhodium, *&c.* to correct it.

To take away gouty, or other arthritic pains.

237. Anoint the part with highly rectify'd ſpirit of human urine, the cold being juſt taken off, once or twice the firſt day, and no longer, unleſs the pain continue.

To check the fits of the gout, and, in ſome meaſure, to prevent them.

238. Take three ounces of ſarſaparilla ſliced thin; and an equal weight of raiſins of the ſun, rubb'd very clean, but not broken; put both into three quarts of ſpring-water, and let the containing veſſel ſtand in a moderate heat, that the liquor may ſimmer for ſeveral hours, yet without burſting the raiſins; keep this decoction well ſtopt, and let the patient uſe it for his only drink.

To appeaſe the pains of the gout, and leſſen the fits of it.

239. Take one part of ſpirit of ſal-armoniac, and three parts of ſpirit of wine, neither of them too well rectify'd: ſhake them together; and having dipt old, clean linen rags in the mixture, apply them to the part affected, ſhifting them now and then.

A poultis to appeaſe pains and aches, even ſuch as are arthritic, or gouty.

240. Boil or ſtew onions in water, till they be ſoft enough to make a poultis; then drain away the water, and beat them; and having ſpread them, to a conſiderable thickneſs, upon a linen-cloth, apply them as hot as the patient can well bear, and let them be kept on all night.

To give eaſe in the fits of the gout.

241. Take three parts of oil of turpentine, and one of chymical oil of ſpike; ſhake them well together, and with this mixture anoint the parts lightly.

Cinnamon-drink, good in gripes and fluxes.

242. Boil two ounces of powder'd, calcin'd hartſhorn, in three pints of ſpring-water, till a pint be waſted; then take it off the fire, and infuſe in it an ounce and half of good cinnamon; ſetting it upon embers, in a cloſe veſſel, for about an hour. Sweeten it with ſugar, and drink about a quarter of a pint at a time. *Gripes.*

An excellent remedy for gripes and fluxes.

243. Of the tincture of corn-poppy-flowers, made with common ſpirit of wine, give from one to two ſpoonsfull, mix'd with a few drops of laudanum, and 4 ounces of black-cherry-water.

For fluxes, eſpecially accompanied with gripings.

244. Take of crude *Lapis Calaminaris*, finely powder'd, two ſcruples, of white chalk one ſcruple; mix them exactly, and give them in a ſpoonfull or two of new milk, twice, or, if the caſe be urgent, thrice a day.

An often try'd medicine for the griping of the guts.

245. Into a quarter of a pint of brandy, put a toaſt of bread whilſt very hot; and as ſoon as it is thoroughly drenched, let the patient take it out, and eat it hot: and this may be repeated, if there be need, two or three times a day.

An often try'd remedy for the gripes in young children.

246. Take of oil of nutmegs, and of wormwood, of each a like quantity; mix them well, and with the mixture a little warm'd, anoint the patient's navel, and the pit of the ſtomach.

To correct the laxity of the gums, and faſten the teeth.

247. To a pint of claret-wine, put a dram of myrrh, and two drams of *Japan* earth, and having diſſolv'd as much of it as you can, pour off the clear, and let the patient waſh his mouth therewith from time to time. *For diſorders in the gums.*

To ſtrengthen the gums, and make the teeth grow fine.

248. Take *Catechu*, or *Japan* earth, and diſſolve as much as you can of it in a pint of claret, or red wine; then decant the liquor warily, and let the patient, now and then, waſh his mouth with it, eſpecially at bed-time.

To

To evacuate the rheum that ſwells the gums, and cauſes the tooth-ach.

249. Diſſolve a ſpoonfull of good muſtard in a pint of *French* wine, and having warm'd it a little, let the patient, from time to time, waſh his mouth with it, and hold it therein for a pretty while together.

An approved medicine for ſcorbutic gums, and to faſten the teeth.

250. Take of white-wine a pint, of alum half an ounce, of juniper berries, and of red ſage, each one ounce; boil theſe together, till a quarter of the liquor be waſted; then put into the remaining part 4 ounces of honey, and let it boil till the ſcum be all riſen; filter it, and put into it one dram of *Balſamum vitæ*.

A medicine for ſcorbutic gums, and to faſten the teeth.

251. Take claret-wine a pint, roch-alum half an ounce; mix, diſſolve, and add ſix ounces of ſtrong tincture of *Japan* earth, made with common brandy.

To take out the marks of gunpowder, ſhot into the skin.

Gun-powder marks.

252. Take freſh cow-dung, and having warm'd it a little, apply it as a poultis, to the part affected; renewing it from time to time, as occaſion ſhall require.

An excellent ſtyptic powder to ſtop hemorrhages.

Hemorrhages.

253. Take equal parts of white ſugar-candy, roch-alum burnt, and white vitriol, pulverize them exceeding well, and mix them diligently; and having dipt pledgets of lint, moiſtned with the white of an egg, into this powder, apply them to the orifices of the bleeding veſſels. And after the dry ingredients are mixt, you may grind them with as much whites of eggs, beaten to water, as will make a paſte, to be throughly dry'd in the air, and then again reduc'd to powder.

A powerful ſtyptic.

254. Make a fine powder of *Lapis Hæmatites*, by grinding it exactly well with an equal or double weight of ſal-armoniac; and of this high-coloured ſublimate, put a little upon the orifices of the bleeding veſſels.

A medicine for ſtanching of blood.

255. For ſtanching of blood, few medicines exceed the colcothar of vitriol, whether waſh'd and freed from its ſalt, or unwaſh'd.

To ſtanch blood, eſpecially in wounds.

256. Take puff-balls, when they are full ripe, which is in autumn, and breaking them warily, ſave the powder that will fly up, and the reſt that remains in their cavities; and ſtrew this all over the part affected, binding it on; or proceeding further, if need be, according to art.

To ſtanch blood from the noſe.

257. Let the patient hold knot-graſs, and *Solomon*'s-ſeal, in his hand, till it grow warm there, or longer, if need be.

To ſtanch blood in any part of the body.

258. Take plantain-water two ounces, barley-cinnamon-water ſix drams, ſpirit of vinegar one ounce, dragons-blood half a dram, ſyrup of myrtles five drams; mix and make a julep, of which let the patient take three ſpoonsfull every hour.

A ſtyptic water, for ſtopping of blood in any part of the body.

259. Put one pound of excellent quick-lime into a clean earthen pot, pour upon it five or ſix pounds of fountain-water, cover the pot cloſe, and let it lie to infuſe for about an hour; then ſtir it with a ſtick for a little time, and let it lie, as before, for 24 hours, ſometimes ſtirring it; laſtly, let it ſettle; and the water being very clear above, pour it off by inclination without ſtirring: take of this water one pound, which being put into a vial, add to it a dram and half of ſublimate, finely powdered; then ſhake all together, ſo that the powder may diſſolve, and be of an orange colour, and the liquor, in the end, clear and limpid; the red powder falling to the bottom. The water being clarified, you muſt pour it from the grounds into another veſſel; and add to it one dram of oil of vitriol, and an ounce of *Saccharum Saturni*. Shake all together, that they may mix the better; afterwards let all ſettle, and pour off the clear water for uſe.

An excellent ſtyptic for ſtopping of blood.

260. Take *Hungarian* vitriol, and alum, of each half a pound, phlegm of vitriol ten pounds; boil to a diſſolution of the vitriol and alum: being cold, filter it through brown paper; and if any cryſtals ſhoot, ſeparate the liquor from them, adding to each pound one ounce of oil of vitriol. Dip cloths into this liquor, and apply them to the part affected.

An often try'd ſtyptic to ſtanch blood, eſpecially in wounds.

261. Take colcothar, as it comes out of the retort, and having powder'd it, roll tents of lint in it, and apply them to the orifices of the

greater veſſels; and fill the cavity of the wound, partly with colcothar too.

An effectual medicine to ſtop bleeding in wounds, and check ſome other hemorrhages.

262. Strew upon the part the fine powder of clear roſin.

A quick remedy for a ſmall freſh cut or wound.

263. Let the patient ſpeedily plunge the hurt part into brandy, and keep it there for a while, till the pain thereby excited, ceaſe, or be much abated: or if the part be unfit for this operation, the liquor may be apply'd to it, immediately, with a ſpunge, *&c.*

For the head-ach.

Head-ach. 264. Take green hemloc that is tender, and put it in your ſocks, ſo that it may lie thin between them and the ſoles of your feet: ſhift the herb once a day.

An excellent medicine for fits of the head-ach.

265. Boil a handful of freſh roſemary, for a pretty while, in a quart of common water; and let the patient cover his head and face with a napkin, ſo that he may receive the ſteam of the decoction for ſome time, as hot as he can well bear it.

An experienced ſternutatory to clear the head.

266. Let the patient ſnuff up, in the morning faſting, a ſmall ſpoonfull, or leſs, of the clarified juice of ground-ivy, or of beets; ſpitting out, from time to time, what liquor comes into his mouth.

An excellent cephalic, good alſo for the eyes.

267. Take the flowers of betony, marjoram, damask-roſes, ſage, and roſemary, all at diſcretion: to theſe add the powder of *Lignum aloes*, and ſome ſeeds of *Nigella Romana.* Reduce all to powder, to be uſed as a hair-powder, when the patient goes to bed.

An experienced medicine for dulneſs of hearing, and hyſterical diſorders.

Hearing diſorder'd. 268. The juice of red onions is excellent for diſeaſes of the ears, or for deafneſs, in the beginning. And betony roots wonderfully prevail againſt all diſorders of the womb.

An approved remedy for deafneſs.

269. Of the breaſt milk of a woman, let fall three or four drops warm, as it comes from the nipple, into the part affected.

For

For difficulty of hearing, from a cold cauſe.

270. Out of a root of garlic, chooſe a chive of a convenient bigneſs; and having paſſed a piece of thread through one end of it, that thereby it may be pull'd out at pleaſure, cruſh it a little between the fingers, and anoint it all over with oil of bitter almonds; put it into the cavity of the patient's ear at bed-time, and draw it out the next morning, ſtopping the ear afterwards with black wool: and, if need require, this is to be repeated with freſh garlic for ſome days ſucceſſively.

For the heart-burn.

271. Take from 15 or 20, to 30 or 40 grains of crabs-eyes, reduced to very fine powder, either alone, or in any convenient conſerve or ſyrup. 'Tis, for the moſt part, beſt to take this medicine, when the ſtomach is empty. *Heart-*

For a hoarſneſs upon a cold.

272. Take three ounces of hyſſop-water, ſweeten it with ſugar-candy; then beat well into it the yolk of an egg, and drink it at a draught. *Hoarſn*

For hyſterical affections, and ſeveral diſtempers of the nerves.

273. Upon one ounce of volatile ſalt of hartſhorn, drop as much ſpirit of nitre as will ſatiate it, when the conflict is quite ceaſed. Digeſt the mixture for a while, that it may acquire a red colour; keep it carefully ſtopt, and give 4 or 5 drops, twice a day, in any convenient vehicle. *Hyſteri orders.*

For the vapours, or fits of the mother.

274. Diſſolve a large quantity of ſea-ſalt in the beſt wine-vinegar; and in this dip a ſoft linen cloth, which, being folded ſo as to make three or four doubles, is to be applied warm to the ſoles of the patient's feet, and kept on till the fit be over.

For the yellow-jaundice.

275. Take an ounce of *Caſtile* ſoap, ſlice it thin, put it into a pint of cold ſmall beer, ſet it on the fire, let it boil, gently, half away; after it has boiled for ſome time, ſcum it once; ſtrain it through a ſieve, warm it, and drink it all in a morning faſting; take a ſmall lump of ſugar after it, and faſt for two or three hours. The patient may walk about, and eat his accuſtom'd meals. If at any time he drinks wine, let it be white-wine. If he be far gone in the diſtemper; two or three days after he may take it once or twice more, and no oftener. Refrain all other medicines: this will keep for a week or longer. *The j*

For the jaundice.

276. Take two or three ounces of hemp-ſeed, and boil them till ſome of them begin to burſt, and a little longer, in a ſufficient quantity of new milk, to make one good draught; which the patient is to take warm, repeating it, if need be, for ſome days together.

For the jaundice in children.

277. Take half an ounce of choice rhubarb in powder, incorporate with it exactly, by long beating, two handsful of well cleanſed currants. Of this electuary let the patient take, every morning, about the quantity of a nutmeg, for ſeveral days together.

An experienced cure for the yellow-jaundice.

278. Take the gall-bladder of a ſheep, and near the top, without emptying the liquor, make a ſmall hole, at which put in two or three drops of the patient's urine; then tie up the upper part of the bladder, and hang it in the free air till it dry up.

An effectual medicine for the yellow-jaundice.

279. Give about half a dram of white hens-dung, dry'd, and mixt with a little ſugar, in a few ſpoonsfull of white-wine.

A medicine almoſt ſpecific for the yellow-jaundice.

280. With clean filings of ſteel mix ſome loaf-ſugar; grind them lon[illegible]reat exactneſs; for in that conſiſts the chief ſecret of this medicin[illegible] Of this impalpable powder, give about half a dram for a doſe, beſides the ſugar, twice or thrice a day, in any convenient vehicle.

A ſpecific for the yellow-jaundice.

281. Take one part of good ſaffron, gently dry'd and powder'd, and incorporate it well with four parts of choice turmeric. Take, alſo, a handful of freſh ſheeps-dung, and let it ſteep in about a quart of ſtrong ale, in a moderate heat, till the liquor be fully impregnated with the dung; then ſtrain it lightly through a linen-cloth. In a large draught of it, give about half a dram of the forementioned powder. This do in the morning faſting, and in the evening about bed-time; giving alſo another doſe on the following morning.

For the yellow-jaundice.

282. Take rhubarb two drams, ſaffron, and mace, of each a dram, hemp-ſeed one handfull; bruiſe them, and put thereto a quart of white-wine, and ſet all in a gentle heat to extract: then take, mornings and evenings, on an empty ſtomach, about a quarter of a pint; and,

when all is ſpent, pour more wine upon the ingredients, adding a little freſh rhubarb and ſaffron, and uſe it as before.

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A medicine, almoſt ſpecific, for the jaundice.

283. With ſmall ale, draw a deep green tincture from freſh ſheep's-dung; and in a little draught of this, give from half a dram to a dram of a powder'd mixture, conſiſting of 4 parts of turmeric, and one of *Engliſh* ſaffron. This doſe may be given twice, or thrice a day; the patient, whom it will diſpoſe to ſweat, keeping very warm; whilſt the operation laſts.

For the black jaundice.

284. Boil a ſpoonfull of honey, gently, and ſcum it, till it come to a good conſiſtence; then add of wheat-flour and ſaffron, reduced to a powder, as much of each, as will lie upon the point of a knife; and having mixed all well, put it over the coals again, till it loſe its ſmell; afterwards keep it in a little earthen pot, and let the patient, with the quantity of a pea, anoint the navel, and fill the cavity thereof with it; repeating the application for ſome days together, when the ſtomach is empty, and abſtaining from meat and drink for about two hours after the medicine is uſed.

To take off the pain and inflammation of ulcers in the legs, and elſewhere.

285. In a quart of water, boil about as much white-bread, as is uſually contained in a half-penny loaf; then add to it two ounces of good ſheep-ſuet cut ſmall; and when that is boil'd a little, add one ounce of powder'd roſin, and a little well-ſears'd brimſtone: of theſe make a cataplaſm, which is to be kept, conſtantly, on the part affected, and ſhifted once or twice a day, as need ſhall require.

Inflamma

To make an iſſue raw, that begins to heal.

286. Take of *Lapis infernalis* one ounce, of crown ſoap an ounce and an half, chalk finely powder'd ſix drams; mix them together carefully, and keep them cloſe ſtopt, except when you mean to uſe them.

Iſſues to run.

An internal medicine for the itch.

287. Boil four ounces of clean quick-ſilver, in a gallon and half of ſpring-water; and let the patient take of this between a quarter and half a pint at a time, after purging.

For the i

An experienced waſh, that quickly cures the itch.

288. Take ſtrong quick-lime one pound, and put to it a gallon of ſpring-water; let them lie together for ſome hours, and then warily pour off the clear; filter the reſt, and take two ounces of quick-ſilver, tyed up in a linen bag; hang it in the liquor, and boil it for half an

hour; then pour off the clear liquor once more, and waſh only the hands with it, twice, or, at moſt, thrice a day.

An experienced liquor to cure the itch in the hands or face, without mercury or ſulphur.

289. Take a handfull of the roots of elecampane, and as much of ſharp-pointed dock; ſhred them ſmall, and boil them in two quarts of ſpring-water, to the conſumption of a pint. Then ſtrain the liquor, and with it let the patient waſh his hands, or other parts affected, once or twice a day.

To mitigate pains in the kidneys.

For diſorders in the kidneys.

290. Take oil of ſcorpions, and oil of bees-wax, of each a like quantity; mix them well, and with it, moderately warm'd, anoint the pained kidney.

An effectual remedy for a ſtoppage in the kidneys.

291. Give, in any convenient liquor, about twelve grains of ſalt of amber for a doſe.

A medicine, almoſt ſpecific, for exulcerations in the kidneys.

292. Having reduced jet to fine powder, give of it about half a dram for a doſe, in white-wine, in the morning faſting, and at bed-time, for ſome days together.

The great medicine of a famous empiric, for the king's-evil.

King's-evil.

293. Give, for a good while together, a pretty ſtrong decoction of devil's-bit.

An uſeful drink for the king's-evil, and ſome diſorders from the like cauſe.

294. Take a large handfull of the leaves of ground-ivy, waſh off the duſt with beer, and put the herb into a gallon of ale-wort; when 'tis ripe for drinking, draw it out into bottles, and let the patient take a draught of it twice or thrice a day, at meals.

An uſeful drink for the king's-evil.

295. Take white-wine a quart, juice of pellitory of the wall a pint, ſpirit of wine half a pint, *Sal prunella* an ounce; mix and diſſolve them, pour off the clear, and ſweeten with white ſugar. The doſe is ſix ſpoonsfull morning and night.

For the king's-evil.

296. Take roots of pile-wort a ſufficient quantity; bruiſe and boil them in hog's-lard till they are criſp, after which preſs them hard out;

and boil, in the like manner, as many more freſh roots, and preſs out again; do this the third time, and keep the ointment, to anoint with morning and night.

An approved remedy for the king's-evil.

297. Set a quart of new milk on the fire till it juſt boils up; then take it off, and put into it two ſpoonsfull of the beſt honey, and ſtir it till it be diſſolved; ſet it on the fire again, and let it boil a little. Then divide it into 4 parts, and drink one part warm, early in the morning, another about 10 of the clock, the third about 4 in the afternoon, and the laſt a little before bed-time. Do this, daily, for two or three months, except when you purge, which muſt be once a week, with *Caryocoſtinum.* Dreſs the ſores, if they run, with any drawing ſear-cloth, or a plaiſter of *Burgundy* pitch. The medicine, tho' not very promiſing, is very famous, from the many cures perform'd with it by a lady.

An uſeful drink to correct ſharp or ſcrophulous humours.

298. Boil two ounces of choice barley, well waſh'd from its duſt, in a quart of ſpring-water, till the grains begin to burſt; then ſtrain the decoction through a clean cloth, and let the patient uſe it for his ordinary drink.

For the king's-evil.

299. Take cuttle-bone uncalcin'd, and having ſcrap'd off the outſide, dry the white part; and of this, finely powder'd, give half a dram for a doſe in mallow or barley water.

A cure for the king's-evil.

300. Take a handfull of *Paronychia folio rutaceo*, called rue-whitlow-graſs, and boil it, every morning, in a quart of ſmall beer; ſtrain it, and drink it for ordinary drink. It waſtes the peccant humour, appeaſes the pain, diſcuſſes the unbroken tumours, and heals the broken ones.

For ſcrophulous tumours in children.

301. Put two handsfull of figwort to a pottle of ſmall ale; of this give a quarter, or half a pint for a doſe. The operation will be promoted, by quenching, ſeven or eight times, in this liquor, a gad of ſteel, about eight or ten inches long.

The Laudanum *of the younger* Helmont.

Helmont's laudanum, *a general remedy.*

302. Take of opium a quarter of a pound; and of the juice of quinces four pounds at the leaſt; cut the opium very ſmall, and mix it well with the juice, firſt made luke-warm; and then digeſt them with a moderate heat, for eight or ten days. After this, filter the tincture; and infuſe therein of cinnamon, nutmegs, and cloves, of each an ounce, or an ounce and half; and let them ſtand for three or four days, or a week longer; then filter the liquor once more, having juſt let it boil a very little, after the ſpices were put in. Now evaporate the ſuperfluous moiſture, till the remainder acquires the conſiſtence of an extract; laſtly, incorporate well herewith two ounces of the beſt ſaffron, reduced to fine powder; or as much of the extract as the ſame quantity of ſaffron wou'd afford. The medicine might be brought to the conſiſtence of a maſs fit for pills; a form wherein I have often adminiſtred it; and upon occaſion too, it might be kept liquid; and if that were the deſign, the evaporation muſt have been but gentle. The doſe of the liquid ſort may be from five drops to ten, as circumſtances ſhall require; but of the pills, a leſs quantity muſt be uſed.

For the leproſie.

For the leproſie.

303. Take pomatum one ounce, flower of ſulphur one dram, *Sal prunella* half an ounce; and having mixt them very well together, anoint the part affected therewith, from time to time, as there is need.

A ſimple antimonial remedy, that has often done much good, even in the leproſie, and continual fevers.

304. Of fine crude antimony, in powder, give about one, two, or three ſcruples morning and evening, according to the age of the patient, in a little ſyrup of clove-july-flowers, or any ſuch vehicle; or elſe mixed with fine ſugar, enough to make it palatable. This may be continued for four or five months, if need require: but if the firſt doſe prove beneficial to the patient, and the caſe not urgent, a ſcruple, or half a dram, may ſerve the turn; nor need the exhibition be continued for ſo long a time.

An often experienced antimonial infuſion.

305. Take one ounce of powder'd antimony, tied up in a little linen bag, and hang it in a gallon of new beer or ale. This liquor, when 'tis ripe, let the patient uſe for ordinary drink; only, if by age or accident it grow ſour, no more muſt be drank, leſt the acidity of the liquor corroding the antimony, ſhould make it vomitive.

To appeaſe ſcorbutic pains in the limbs.

306. Spread liquid ſtyrax thin, upon ſilk, or very fine kid-leather; *Limbs pain'd.* and keep it upon the part affected, till it dry up of it ſelf, or till the patient has no more need of it.

An experienced medicine for a contracture, produced by keeping the limbs too long in an undue poſture.

307. Anoint well, once or twice a day, the part affected, with dogs-greaſe; chafing it in with a warm hand, and keeping the part warm afterwards.

For the dyſentery, and other ſharp fluxes.

308. Take the ſtalks and leaves of flea-bane, dry them gently till *Looſeneſs.* they be reducible to powder; of which give about one dram at a time, twice or thrice a day, in any convenient vehicle; or elſe incorporate it with conſerve of red roſes.

A remedy often uſed with ſucceſs in fluxes, and dyſenteries.

309. Cut freſh roots of biſtort into thin ſlices, and moiſten them well with fair water and wine, to make them more ſoft; then preſs out the juice ſtrongly; and of this give about three or four ſpoonsfull in red wine, or ſome other convenient liquor.

A ſucceſsful medicine for fluxes of the belly.

310. Mix with rice-meal about a fifth part of finely powder'd chalk; boil theſe in water, or in milk, like a haſty-pudding, to be moderately ſeaſon'd with ſugar, and powder'd cinnamon; and let the patient eat it at meals.

For a looſeneſs.

311. Boil a convenient quantity of cork in ſpring-water, till the liquor taſte ſtrong thereof; and of this decoction let the patient drink a moderate draught, from time to time, till he finds himſelf reliev'd.

For a looſeneſs.

312. Mix up 15 grains of powder'd rhubarb, with half a dram of diaſcordium; and let the patient take it either going to bed, or early in the morning, after his firſt ſleep.

An experienced remedy for ſharp fluxes of the belly.

313. In a pint of new milk diſſolve two ounces of loaf-ſugar, and about the bigneſs of a walnut of mithridate; give this mixture, moderately warm, for a glyſter, to be repeated if there be occaſion.

To ſtop fluxes, and the whites.

314. Give the patient, from time to time, a moderate quantity of a decoction of half an ounce of iſing-glaſs, in about a pint of new milk.

For fluxes, eſpecially thoſe cauſed by ſharp humours.

315. Thoroughly drench a toaſt in good oil-olive, and let the patient eat it.

An excellent remedy againſt fluxes.

316. Boil unſalted butter gently, till a conſiderable part be conſumed, skimming it from time to time, whilſt it ſtands over the fire: of this butter melted, give now and then a conſiderable quantity, as the patient is able to bear it. This medicine was very ſucceſsful in *Ireland*.

An often try'd glyſter in fluxes, eſpecially from ſharp humors, and in ſome other diſtempers of the bowels.

317. In a quart of new milk, boil two ſmall ſpoonsfull of groſly powder'd rice, to the conſiſtence of cream, then diſſolve in it two ounces of ſheep-ſuet; and having ſtrain'd it, give it, at once, for a glyſter.

For ſuppreſſion of the Menſes.

Menſes ſuppreſs'd. 318. Give, for three mornings together, about the expected time of the evacuation, a dram of the galls and livers of eels, dried and powder'd.

A good medicine to increaſe milk in ſuch as give ſuck.

Milk to increaſe. 319. Make pottage with lentils, or vetches, and let the patient uſe it freely.

To increaſe milk in nurſes.

320. Dry well-cleanſed earth-worms, ſo that they may not ſmell ill, and yet be pulverable. Of theſe, reduc'd to powder, give half a dram, or two ſcruples, for a doſe, in wine, or any other proper vehicle.

For diſorders in the nervous ſyſtem.

Nerves diſorder'd. 321. Take of the freſh roots of the male piony one ounce, of the ſeeds of the ſame plant two drams; and with a ſufficient quantity of the ſyrup of piony, or ſome conſerve of a like nature, beat them up into an electuary; of which the patient may take the quantity of a ſmall nutmeg, or more, twice or thrice a day.

For obſtructions, and ſeveral diſeaſes thence proceeding.

Obſtructions. 322. Let the patient drink, every morning faſting, a moderate draught of his own urine, newly made, and whilſt 'tis yet warm; forbearing food for an hour or two after it.

A choice medicine for the palſie.

The palſie.

323. Take ſarſaparilla a pound and half, bark of guaiacum, china in chips, of each two ounces and a half; boil all in ſix pints of water, to the conſumption of a third part: at the end add raiſins of the ſun ſton'd 4 ounces, liqueriſe bruis'd one dram, twelve fat figs; boil and ſtrain it. This is to be uſed warm for ordinary drink.

For a weakneſs in the hands, ariſing from the palſie, or rheumatiſm.

324. Take the tops of roſemary, and, bruiſing them a little, make them up into a ball of the bigneſs of a ſmall orange. Let the patient often roll one of theſe balls between his hands, and, for ſeveral hours in a day, graſp one of them in the hand affected, that it may grow hot there, and tranſmit its effluvia into the part. Continue this courſe as long as the diſtemper requires.

An external remedy for paralytic diſorders.

325. Make a ſtrong decoction of roſemary-leaves, or flowers, and let the patient long hold the part affected in the liquor, kept very warm. If, after ſeveral trials, this medicine prove ineffectual, mix ten drops of oil of worms with it, and 4 or 5 drops of oil of turpentine; and with this mixture warm'd, anoint the part from time to time; or elſe let the patient keep the part, for a good while together, in warm rain-water, to diſſolve the ſcorbutic ſalts.

For the pleuriſie.

The pleuriſie.

326. Cut green broom-tops ſhort, and therewith fill a pipkin, of a pint and half, and with ale; boil it ſoftly, till it be waſted to two or three ſpoonsfull; and then it will look black, like treacle, and be thick. When 'tis enough, and cold, add as much mithridate as a nutmeg; mix it well, and give it the patient, warm, in bed, and let him ſweat for three hours, or more, after it. If it relieve not at firſt, repeat it next day.

An experienced medicine for the pleuriſie.

327. Take ſeveral balls of freſh ſtone-horſe-dung; cover them whilſt they are warm, with good white-wine; let them ſtand a little, and then preſs out gently, through a clean linen cloth, as much liquor as the mixture will readily afford; and of this, ſomewhat warm, give a moderate draught from time to time.

The eſſence and ſalt of hartſhorn, experienced medicines in the pleuriſie, diſorders of the brain, &c.

328. Diſtil hartſhorn, broken on an anvil into pieces about the bigneſs of the little finger, in a ſand-heat; and afterwards ſeparate the ſpirit and volatile ſalt from the reddiſh, lighter oil, and free them

MEDICINE.

by two rectifications from phlegm and feculencies, in tall glaſſes, with a very gentle heat. The doſe is from eight or ten drops of the ſpirit, or as many grains of the ſalt, to ſixty times the quantity of either, in any vehicle, except milk, that is not acid. Theſe medicines have been ſerviceable in the epilepſy, convulſions, in fevers, obſtructions of the ſpleen, liver, womb, *&c.* and commonly prove diaphoretic, without heating the blood too much. Only they ſhou'd not be exhibited when the *primæ viæ* are block'd up by groſs humours. 'Tis proper to preſerve this ſalt in the ſpirit; otherwiſe 'tis apt to fly away.

An experienced medicine for the pains of the hemorrhoids.

The piles.

329. Take the ſole of an old ſhoe, worn by ſome man that walks much, cut it in pieces, and burn it to a friable, tender coal; reduce this to impalpable powder, and then, with a ſufficient quantity of unſalted lard, make it into an unguent, wherewith the part affected is to be anointed from time to time.

For the hemorrhoids.

330. Uſe a ſuppoſitory of hogs-lard, bacon, or gooſe-greaſe.

For the hemorrhoids.

331. In the yolk of an egg, or ſome convenient ſyrup, or conſerve, give from half a dram, to one dram, of flower of brimſtone, once, or, if the caſe be urgent, twice a day. The powder may be, alſo, given in milk to thoſe who like it.

An internal remedy for painful hemorrhoids.

332. With about two ſcruples of choice ſulphur vive, mix a little ſugar, and give this doſe once or twice a day.

For the pain and tumour of the hemorrhoids.

333. Take freſh leeks, the whole plant, ſhred ſmall, fry them well with freſh butter, till they become fit for a cataplaſm, to be apply'd very warm to the part affected, and renewed from time to time.

An uſeful medicine for the pain of the hemorrhoids.

334. Make up flower of brimſtone, and an equal weight of fine ſugar, with a ſolution of gum-dragon, into tablets that may weigh about a dram each; one of which may be given twice a day.

For the pain of the hemorrhoids.

335. Mix up *Album Græcum*, reduced to an impalpable powder, with a ſufficient quantity of gooſe-greaſe; and by grinding it well in a leaden mortar, bring it to a black ointment, to be apply'd moderately warm to the part affected.

An experienced remedy for unbroken hemorrhoids.

336. Incorporate calcin'd oyſter-ſhells, with as much honey as will make up the powder into an ointment; with which the part affected is to be tenderly anointed from time to time.

A very ſucceſsful medicine for the hemorrhoids.

337. Take maiden-leeks, that is, thoſe which have never been tranſplanted, and caſting away the green part, make of the bulbous one, and a ſufficient quantity of whole oatmeal, a caudle, whereof let the patient eat plentifully.

For the pain of the hemorrhoids.

338. Boil a handful of yarrow, in about a pint and half of poſſet-drink, in a cover'd veſſel, till it be ſtrong of the plant; and of this decoction let the patient drink, pretty plentifully, from time to time.

For the pain of the hemorrhoids.

339. Take of maſtic, olibanum, aloes, and myrrh, of each a like quantity, powder and mix them very well; then lay a ſufficient quantity of this upon a pledget of lint, moiſten'd throughly with ſpirit of wine, over a few well-kindled coals, that the powder may melt, and be clapt hot to the pit of the ſtomach, or navel.

For the pain of the hemorrhoids.

340. Boil a quart of new milk for a while; then taking it off the fire, preſently put it into ſome open-mouth'd veſſel, and let the patient ſit to receive the fume of it.

To appeaſe the pains of the hemorrhoids.

341. Roaſt two freſh eggs pretty hard, then peel off the ſhells, and mince them. To theſe add two pippins, the cores being firſt taken out, that have been thoroughly roaſted; incorporate them very well with the eggs, reducing all to a kind of cataplaſm, to be apply'd very warm to the part affected.

For pains of the hemorrhoids.

342. Boil half a dram of good flower of brimſtone, a little, in new milk, and let the patient take, in the morning faſting, both the liquor and the powder, for many days ſucceſſively. The like doſe may, upon occaſion, be taken between 4 and 5 in the afternoon.

An experienced remedy for the piles.

343. In 4 ounces of ſpring-water, diſſolve one dram of ſalt of tartar, and apply ſoft rags dipt in it, warm, to the part affected, ſhifting them from time to time.

For the piles.

344. Take the powder of earth-worms, waſh'd in white-wine, and incorporate it with as much hens-greaſe, as will ſerve to make it up into an ointment. Apply this to the part affected.

For tumours and pains of the hemorrhoids, not too much inflamed.

345. Let the patient dip his finger in balſam of ſulphur, made with oil of turpentine, and anoint the tumours, whether external or internal, once or twice a day.

For the pains of the piles.

346. Take of myrrh, olibanum, and common frankincenſe, of each a like quantity; having powder'd them, mix them very well, and let the patient receive the fume of this mixture, caſt upon a chafing-diſh of embers, in a cloſe-ſtool, for about a quarter of an hour.

To appeaſe the pain of the hemorrhoids, whether internal or external.

347. Take two parts of flower of ſulphur, and one of ſugar, very finely powder'd; mix them exactly together, and make them up with a ſufficient quantity of mucilage of gum-dragon, into lozenges of about a dram each: of which you may give one at a time, thrice a day, or, if need be, 4 or 5 times.

For the piles.

348. Take balſam of ſulphur made with oil of turpentine, and ointment of tobacco, equal parts; incorporate them well, and anoint the grieved place therewith.

Aloetic pills that ſcarce occaſion the piles.

349. Give of the *Frankfort* angelical pills, from one ſcruple to two ſcruples, or more, for a doſe.

A medicine for the pain and tumour of the hemorrhoids.

350. With rags dipt in the patient's own urine, foment the parts affected, and then anoint them with ointment of populeum. This do three or four times a day; and if the tumours be internal, you may inject a little of the urine.

A

A remedy, by which many dogs bitten by a mad-dog, have been preſerved from running mad.

Poiſons to cure.

351. Take three whole plants of the herb called roſe-plantain, or by ſome, ſtar-plantain, *i. e. Lychnis ſalmantica Clus.* and having chopt them ſmall with a convenient quantity of butter, let the bitten dog take it for the firſt day; the ſecond day give him 5 plants order'd as before, and the next day 7.

Againſt the bites of vipers, and other venomous creatures.

352. As ſoon as ever the perſon is bitten, a hot iron may be held as near the wound as the patient can poſſibly endure it, till it has drawn out the poiſon.

An approved medicine for the bite of a viper.

353. Apply white hore-hound, beaten into the form of a poultis, to the part affected; and give the patient a ſpoonfull or two of the juice of the ſame herb to drink.

Elixir Salutis.

Purging medicines.

354. Take of the ſeeds of aniſe, ſweet fennel, coriander, and parſley, of liquorice, and choice leaves of ſenna, each two ounces; of raiſins of the ſun one pound; of elecampane-roots, and guaiacum-wood, of each one ounce. Mix theſe ingredients, and pour on them two quarts of *Aqua vitæ*; let them infuſe for 48 hours; then put them all into a hair-bag, and ſqueeze them ſtrongly in a preſs, and paſs what is ſtrained through an hippocras bag, after the liquor is ſettled. Keep this in bottles, well ſtopt, in a cool place, and give of it two or three ſpoonsfull at a time, in the morning faſting, and, if need require, at bed-time.

A purging electuary, eſpecially for children.

355. Take an ounce of choice rhubarb, reduced to fine powder, and eight ounces of very good currants pick'd, waſh'd, and rub'd dry; beat theſe together in a marble mortar for near two hours. Of this electuary let the patient take about the bigneſs of a cheſnut in the morning faſting, and at bed-time: or, if the caſe be very urgent, the medicine may be taken thrice in 24 hours.

A pleaſant purge for children, and delicate perſons.

356. In the yolk of an egg, diſſolve, by rubbing in a clean ſtone mortar, about ſix grains of roſin of jalap finely powder'd; and when the ſolution is made, gradually incorporate with it two or three ounces of ſuccory-water; which, by this operation, will be made into a kind of emulſion: ſweeten it at pleaſure, and give it in a morning faſting.

A try'd way to make an artificial wine, that is ſoon drinkable, and ſerves to keep the body ſoluble.

357. Pour a gallon of boiling water upon three pounds of raiſins of the ſun, ſton'd and well bruis'd; by ſqueezing and preſſing, get out the juice; and having ſtrain'd it, add thereto a pound of brown ſugar-candy.

An approved outward medicine to cauſe reſt without opiates.

Reſt to cauſe.

358. Take of roſe-water eight ounces, good wine four ounces, ſtrong vinegar two ounces; mix theſe well, and having warm'd ſtupes in the liquor therewith foment the part affected; laying them on moderately warm, and taking them off when they begin to grow cold: keep fomenting between a quarter, and half an hour, before the patient compoſes himſelf to reſt.

A good medicine for rheums, or a cold newly taken.

Rheums.

359. To four ounces of ſpring-water put three leaves of colts-foot, a pugil of maiden-hair, and one dram of ſtick-liquorice: when the water is ready to boil, put in the fore-mentioned ingredients; let it boil a little, then take it off the fire, and having preſently ſtrain'd it, let the patient drink it hot, like tea, whilſt he is in bed: do this three or four nights ſucceſſively.

A very good ſyrup for thin rheums.

360. Take the ſyrups of jujubes, dried roſes, and of corn-poppy-flowers, of each a like quantity; mix and uſe them as neceſſity requires.

A powerful medicine to ſtop ſharp rheums.

361. Take a dram of *Japan* earth, and make thereof a decoction in five or ſix ounces of white-wine, or ſome diſtilled water. Of this give two or three ſpoonsfull night and morning.

A ſucceſsful remedy for a kind of rheumatiſm, and a contracture of the limbs that followed upon it.

The rheumatiſm.

362. Take the inward bark of an elder-tree, cut it into ſmall bits, and with them, looſely placed, fill about the third part of a bottle; then pour in as much ſmall ale, or beer, as will fill up the remaining part of the veſſel; ſtop it well till the liquor taſte ſtrong of the bark; and let the patient drink a draught once or twice a day; or, if he can, let him take it as a diet-drink.

Ens veneris, *an experienced ſpecific for the rickets.*

The rickets.

363. Calcine good *Dantzick*, or rather *Hungarian* vitriol, till the calx become of a dark red, or purpliſh colour; then thoroughly dulcify it,

by repeated waſhings in warm water, dry it, and mix it exquiſitely with an equal weight of pure ſal-armoniac in powder; put the mixture into a glaſs retort, able to hold above three times the quantity, and ſublime it in a ſand-furnace, by degrees of fire, for ten or twelve hours; increaſing the fire at the laſt, till the bottom of the retort be red-hot. If what is ſublimed, which is the medicine, be not of a good yellow, return it to the remainder, mix it well therewith, and ſublime it once more. The doſe is two or three grains to little children, ten or twelve to grown perſons, and ſometimes twenty or thirty, in diſtilled water, or ſmall-beer, but not in milk. It may be given at any time, upon an empty ſtomach; but I moſt commonly give it at bed-time. When it operates ſenſibly, 'tis by ſweat, and, ſometimes, by urine. I exhibit this medicine, alſo, in fevers, and other diſeaſes, to procure ſleep; which it does more ſafely than opiate preparations. 'Tis, alſo, powerful againſt worms, obſtructions of the *menſes*, and to ſtrengthen the appetite.

An effectual medicine for the roughneſs of the lips, and to heal parts that have the ſkarf-skin worn off.

Roughneſs of the lips.

364. Take two parts of wax, and one of freſh butter, melt and incorporate them over a gentle fire; and let the mixture drop into ſmall cakes, upon a glazed tile, dipt in water, or a piece of wetted white paper.

To take off the heat and roughneſs of the skin, eſpecially on the lips.

365. Anoint the part affected with freſh cream.

For a rupture, eſpecially in a child, or young perſon.

Ruptures.

366. Reduce the root and leaves of dove's-foot-crane's-bill, to fine powder; and of this let the patient take about half a ſpoonfull at night and morning, for three or four weeks together; waſhing it down, each time, with ſome ſpoonsfull of red wine.

For ruptures in the belly, eſpecially in children.

367. Having well cleanſed ſome *Solomon*'s-ſeal roots, ſcrape one ounce of them into a quart of broth, and let the patient take a meſs of it for his breakfaſt; or elſe give half a dram, or two ſcruples, of the powder of it, at a time, in any convenient vehicle.

An uſeful drink for a beginning ſcurvy.

The ſcurvy.

368. To a quart of ſmall-beer, put over-night, about a handful of ſcurvy-graſs-leaves; and let the patient drink this liquor at dinner, for ſix or eight weeks together.

An excellent drink for the ſcurvy.

369. Let two handsfull of water-trefoil work in about eight gallons of wort, inſtead of hops; and let the patient uſe it for his ordinary drink.

For the ſcurvy.

370. From the freſh gather'd tops of fir, a little bruis'd, abſtract ſpirit of wine; and with this liquor draw a deep tincture from other freſh tops; of which tincture reduce ſome part into an extract, whereof to form pills; keep theſe, the tincture, and the impregnated liquor apart, to be employed ſeparately, or conjointly, as occaſion may require.

For ſcorbutic, and other pains in the limbs.

371. With red and unſophiſticated oil of peter, anoint, from time to time, the part affected.

An experienced remedy for a ſhort breath.

Short breath. 372. Take of choice caſtor powder'd, two, three, or four grains; mix this with ten or eleven grains of *Gaſcoign*'s powder, and ſome little ſyrup, or conſerve; and when taken, let it be waſh'd down with a mixture of five drams of peny-royal-water, and two drams of compound bryony-water.

An experienced medicine for want of ſleep, proceeding from great heats in the head.

Sleep to procure. 373. Take the ſcrapings of the paleſt carrots, enough to make a cataplaſm, of about two inches broad, and of the thickneſs of a half-crown. Let the patient apply this, in a piece of double linen, to his throat, ſo that it may reach to the jugular veſſels on each ſide, when he goes to bed, and let it lie on all night; if the firſt application do not prevail, 'tis to be apply'd the following night; and ſo a third and fourth time, if need require.

An experienced medicine for the ſmall-pox, eſpecially in children.

Small-pox. 374. Take the little balls of freſh ſheeps-dung, and having freed them from ſtraw, duſt, *&c.* put a handfull of them, thus cleans'd, into a quart of good white-wine; and in a veſſel well ſtopt, let them infuſe in a moderate heat, till the liquor be well impregnated. Strain this infuſion, and give of it warm about a ſpoonfull at a time, once in two or three hours, or oftener.

For heat about the orifice of the ſtomach.

Diſorders in the ſtomach. 375. Make a ſyrup with the juice of houſleek and ſugar, and give about one ſpoonfull of it from time to time.

A

A ſtomachic tincture.

376. Take agrimony two drams, tops of the leſſer centory one dram, coriander-ſeeds bruiſed one ſcruple, ſaſſafras ſhavings and bark one dram, gentian-root half a dram, zedoary-root ten grains; pour upon theſe three quarters of a pint of boiling ſpring-water, cover it, and let it ſteep for twelve hours, then ſtrain it, put it in a bottle; and having let fall a drop of oil of cinnamon upon a lump of ſugar, put it into the liquor. The doſe is three ſpoonsfull twice a day, an hour or two before meals.

An excellent external remedy to ſtrengthen the ſtomach.

377. Take wormwood, mint, and mugwort, and by beating them well in a ſtone mortar, make a cataplaſm, to be apply'd ſomewhat warm to the ſtomach, and kept upon it for a pretty while.

An often try'd remedy to ſtrengthen the ſtomach, and take off griping pains in or near it.

378. Take the *Emplaſtrum ſtomachicum* of the *London* diſpenſatory, and let fall upon it five or ſix drops of oil of cinnamon; rubbing it well over with your finger, and ſo apply it to the patient's ſtomach: as ſoon as it grows dry, remove it; and having ſcrap'd the plaiſter, and warm'd it on the wrong ſide, let fall ſome drops of the oil of cinnamon upon it, and apply it again.

A plaiſter to ſtrengthen the ſtomach and cheſt.

379. Take of cinnamon, nutmegs, cloves, and mace, of each a ſufficient quantity, powder'd; ſtrew ſome of the powder over the bottom of a deal box, of a convenient length and breadth, and fit it with a cover to ſhut cloſe; upon this powder lay a piece of clean flanel well dry'd, and ſtrew it over thinly with ſome of the ſame powder; then lay on another piece of the like flanel, of the ſame dimenſions with the former; and upon that likewiſe, if need be, ſtrew a little more powder. This done, ſhut the box till the time of uſe, and then take out one of the pieces of flanel, and having lightly duſted off the powder, lay it on the patient's breaſt, ſtomach, and belly; and let it lie on for ſome days. When you perceive its virtue begin to languiſh, ſubſtitute the other piece of flanel, and put the firſt in the box to receive new virtue; and ſo proceed, alternately, as long as you need the medicine; adding now and then ſome freſh powder occaſionally. Each piece of flanel ought to be long, and large enough to cover the breaſt, and to reach from about the paps to the navel, or lower.

To give eaſe in the pains of the ſtone, even that of the bladder.

The ſtone:

380. Take the tranſparent ſpar that grows upon the veins of lead-ore, and having reduced it to fine powder, give from half a dram, to

a whole dram of it at a time, in a moderate draught of ſome convenient vehicle. That which the diggers name cawk, being white and opake, is not the medicine I mean, but the tranſparent matter, which eaſily breaks into ſmooth fragments, and in the fire cleaves into ſeveral pieces, ſmooth and prettily ſhaped.

A ſafe and eaſy medicine in fits of the ſtone.

381. Take ſack, or claret-wine, and by ſhaking, or otherwiſe, mix with it an equal quantity of oil of walnuts; and of this mixture give from four or ſix, to eight or ten ounces at a time, by way of glyſter.

For the ſtone.

382. Give of the ſeed of flix-weed, about as much as will lie upon a ſhilling, either whole, or groſly bruis'd, in any convenient vehicle.

An anodyne glyſter in the ſtone.

383. Take marſh-mallow roots half an ounce, leaves of the ſame, mallows, and mullein, of each one handfull, camomile-flowers two pugils: boil them in a ſufficient quantity of water to ten ounces, ſtrain, and add the yolks of two eggs, and oil of camomile an ounce and half; mix and make a glyſter.

An excellent medicine in fits of the ſtone.

384. Boil leſs than a handful of red chick-peaſe, or cicers, ſoftly in a quart of ſpring-water, till the liquor be red, and well impregnated with the ſeeds: ſtrain this decoction, and ſweeten it with ſyrup of marſh-mallows, out of which all the ſtronger diuretics are left.

For the ſtone.

385. Sweeten a quarter or half a pint of ſimple arſmart-water, with a little ſugar, or ſome convenient ſyrup; aromatize it with a little nutmeg, and give this mixture for one doſe.

For the ſtone and gravel in the reins and bladder.

386. Take equal weights of common daucus-ſeed, and of burdoc-ſeed; and having mixt theſe together, put one ounce of the mixture to a gallon of ſmall ale, and let the patient uſe it for conſtant drink.

A good liquor to uſe, as drink, in a long fit of the ſtone.

387. Make poſſet-drink of three or four parts milk, and one of white-wine. Into two quarts of this poſſet-drink, ſcrape a nutmeg or two; add a little juice of lemmon, and, if you pleaſe, ſweeten it a little with ſyrup of marſh-mallows. Take of this drink a conſiderable quantity at a time, and uſe it often in a day..

A good medicine for the ſtone.

388. Sweeten a pint, or a quart, of new ale with pure honey, and boil it to the conſumption of about one half, skimming it well from time to time. Then diſſolve in it the yolk of a new laid egg; and let the patient drink a large draught of this mixture once or twice a day, till he find relief.

A ſerviceable medicine in an actual fit of the ſtone.

389. Take the decoction, made according to the *London* diſpenſatory, for the ſyrup of marſh-mallows, but with half the quantity of the ingredients. This decoction being well clarified, let the patient take of it warm, ſix, eight, or ten ounces at a draught, from time to time.

A cure for the ſtone; taken out of the hiſtory of Barbadoes, *written by Mr.* Lygon.

390. After the ſtoppage of urine for more than 14 days, the following medicine did not only break, but bring away all the ſtones and gravel. And in about three weeks after, the like pains returning, the ſame medicine had the like effect, within ten hours after the taking thereof.

Beat the dry pizzle of a green turtle, or tortoiſe, which lives in the ſea, to powder; and take of it as much as will lie upon a ſhilling, in beer, ale, white-wine, or the like; and in a very ſhort time it will perform the cure. Theſe creatures are to be had eaſily, both at the *Caribee* and *Lucaick*-iſlands.

To expel the ſtone in a fit.

391. Diſſolve a large proportion of crabs-eyes powder'd, in good white-wine vinegar; and of this drink let the patient take from two ſpoonsfull, to five or ſix at a time.

For the ſtone.

392. Give every morning faſting, and every night going to bed, half a dram of the powder of winter-cherries, in a draught of parſly, or arſmart-water, or in a glaſs of white-wine.

An often try'd medicine for the ſtone, whether of the kidneys or bladder.

393. Take of pure white-wine, or *Rheniſh*, and of fennel-water, each one pint; mix them, and add half an ounce of live wood-lice well cleanſed, and one lemmon ſliced; let them infuſe in a veſſel well ſtopt, for four or five days, and then let the patient take about four ounces at a time twice a day.

For the ſtone.

394. Diſtil arſmart in a common roſe-water ſtill, and give ſome ſpoonsfull of the water in or before the fits.

A chymiſt's ſecret for the ſtone.

395. Take borax finely powder'd, and make it up with choice turpentine into pills, whereof one doſe ought to contain from one ſcruple to two; waſh theſe down with a few ſpoonsfull of the tincture of *Lignum Nephriticum*, made in water, or of cochineal; or if the caſe be urgent, you may give from twenty to thirty grains of the borax, and about a fifth part of myrrh, diſſolved in two ſpoonsfull of the tincture of *Lignum Nephriticum.*

To make a nephritic tincture, often found to relieve in the ſtone.

396. Calcine oyſter-ſhells till they be very white; of theſe take two parts, and one of *Rheniſh*-wine tartar; pulverize them apart, and mix them diligently; pour on the mixture a little fair water, and let the ingredients work on each other till the conflict be over; then ſtir the mixture, and pour on more liquor; and when the effervescence ceaſes, put on a little more, and ſo proceed till no conflict be made. Evaporate it to a kind of ſoft mucilage; digeſt this a while, decant the liquor, and filter it, and you will have it, if it be not too phlegmatic, of a fine red colour. Of this the doſe is from ten or fifteen, to thirty drops, or more, in any convenient vehicle.

An uſeful aliment for ſuch as are troubled with pains of the ſtone.

397. Let the patient eat five or ſix onions roaſted, and ſparingly butter'd, either in the morning, at meals, or other times, if the caſe be urgent. The diſtilled water of onions is, likewiſe, uſeful in the ſame diſtemper.

The medicine of a famous empiric for the ſtone.

398. Take amber, ſea-horſe pizzle, and nitre, of each a like quantity, (but in caſe of ulcerated kidneys, put only half the quantity of the amber) and an eighth part of nitre. Pulverize each apart, and make them up into pills with *Chio* turpentine; take ſix or ſeven pills (of about ten to a dram) morning and evening.

For the ſtone.

399. Take *Straſburgh* turpentine two ounces; grind it well with the yolks of eggs, and mix therewith the following ſyrup. Take water a pint and half, *Sal Prunellæ* an ounce and half; mix, diſſolve, and with a pound of honey, boil all into a ſyrup. The doſe is two or three ſpoonsfull morning and night.

An excellent medicine for the ſtone in the bladder.

400. Take powder of comfrey-roots an ounce and half, marſh-mallow roots three ounces, liqueriſe-powder two drams, ſeeds of daucus of *Creet* two drams, ſeeds of purſlane, and of winter-cherries, each half a dram, nutmegs two drams, ſaffron one dram, the ſpecies *Diamargariton frigid.* ſix drams, ſyrup of marſh-mallows four ounces; mix and make a ſoft electuary; of which let the patient daily take the quantity of a walnut. It is good againſt the ſtone in the reins and bladder, but chiefly againſt the latter; as alſo againſt the ſtrangury, dyſuria, *&c.*

A famous lithomiſts receipt for a ſoft ſtone in the bladder, after it has been cruſh'd and broken.

401. Take the waters of melons, citruls, drop-wort, and parſley, the ſyrup of the five opening roots, and *Syrup. Byſantinus*, of each two ounces, compound oxymel one ounce; mix theſe, and take a fourth part of the whole in the morning faſting, and eat nothing after it for eight hours; take another fourth at night going to reſt, and the remainder on the day following, after the ſame manner. Then on the third day,

Take lenitive electuary three drams, ſyrup of damask-roſes two drams, the pulp of tamarinds one dram, diſſolve them in three ounces of whey; and drink the whole in the morning early. On the fourth morning take a dram of the following powder, in a quarter of a pint of the following apozem, and half an ounce of the oil of ſweet almonds.

Take ſandiver, or rather wood-aſhes, the powder of ſcorpions, or of well-cleanſed earth-worms, *Lapis Spongiæ*, and *Lapis Judaicus*, *Acorus*, the ſeeds of marſh-mallows, gromwell, mil-foil, ſaxifrage, of each a dram; the ſeeds of lettice, and the four greater cold ſeeds, of each half a dram, the troches of winter-cherries, and pimpinel root, of each two drams; make the whole into a fine powder.

Take pellitory of the wall, and marſh-mallow root, of each a handful, parſley-ſeed, and liqueriſe, of each half an ounce, the ſeeds of winter-cherries an ounce; boil them in two quarts of rain-water, and one of white-wine, till half is waſted, and ſweeten the remainder with honey. Then, on the fourth day, eat a hedge-ſparrow with your ſupper, and afterwards anoint the loins, *Pubes*, and the whole region of the kidneys, with the oil of citron-ſeeds, and of ſcorpions: or theſe oils may be injected into the bladder. And thus continue the uſe of the powder, apozem, ſparrow, and the oils every day, till the ſand or fragments of the ſtone come away with the urine.

For a ſtrain.

402. In the ſtrongeſt vinegar boil a convenient quantity of wheat-bran, to the conſiſtence of a poultis. Apply this, as early as may be, to the part affected, and renew it when it begins to grow dry. *Strains.*

For a freſh ſtrain.

403. Take wormwood, and pound it very well in a ſtone-mortar; then put into it as much of the whites of eggs, beaten to water, as will make it into a poultis, to be applied to the part affected.

A ſtrengthening plaiſter after a ſtrain, or when there is any weakneſs in the joynt.

404. Melt down together, and incorporate two parts of diapalma, and one part of ***Emplaſtrum ad Herniam***; ſpread this mixture (not very thick) upon leather, and lay it to the joint to be ſtrengthened.

For a freſh ſtrain.

405. Make up clay with as much vinegar, as will bring it to the conſiſtence of a ſtiff cataplaſm: then warm it a little, and apply it to the part affected.

For a freſh ſtrain.

406. Take four ounces of bean-flower, and two ounces of wine-vinegar; of theſe make a cataplaſm, to be applied a little warm to the part affected: but if this ſhould prove too ſharp, boil two drams of litharge a little in the vinegar, before you put in the bean-flower.

For a recent ſtrain.

407. Boil a handful of red-roſe leaves in a pint of claret-wine, for a little while, in a cloſe veſſel, till the liquor be ſtrong of the plant. In this, well heated, dip a piece of linen or flanel, and wringing out the moiſture, double it, and apply it hot to the part affected; uſing a fillet to keep it on.

My lord Bacon's *experienced medicine for a recent ſtrain or bruiſe.*

408. Boil a handful of freſh wormwood, in a ſufficient quantity of ſtrong ale, to the ſoftneſs of a poultis; then take it off the fire, and when you apply it, which you ſhould do whilſt 'tis very hot, put to it a ſpoonfull or two of common brandy.

A plaiſter for a recent ſtrain.

409. Take equal parts of the plaiſters called diapalma and oxycroceum, make of them a compounded plaiſter, to be ſpread upon thin leather, and apply it to the part affected; renewing it, if need be, twice a day.

A

A remedy for a recent ſtrain.

410. Take two ſpoonsfull of vinegar, and beat into it very well the white of an egg; and ſpreading it upon flax, or tow, apply it to, and keep it on the part affected.

For a freſh ſtrain.

411. Boil bran in wine-vinegar to the conſiſtence of a poultis; apply it warm, and renew it once in twelve hours, for two or three times.

To ſtrengthen a part weakned by ſublaxation.

412. Spread *Emplaſtrum Divinum* upon ſoft leather, and apply it; keeping it on for ſome time.

An effectual medicine for a ſtrain.

413. Take comfrey-roots, beat to a pulp, half a pound, powder of *Japan* earth four ounces, ſpirit of wine a ſufficient quantity; mix and apply it to the part.

A plaiſter to ſtrengthen the joints after the gout, and haſten the going off of the pain.

414. Take of paracelſus and diapalma, of each a like quantity, melt and incorporate them exactly together, and ſpread the mixture, very thin, upon fine leather, to be us'd as a plaiſter to the part affected.

A medicine, almoſt ſpecific, for a teneſmus.

415. Mix balſam of ſulphur terebinthinated with linſeed-oil, or ſome other convenient oil, till the balſam be thereby ſo far allay'd, that the patient may well endure it; and then let him dip his finger therein, and uſe it as a ſmall ſuppoſitory two or three times, or oftener in a day. *Teneſmus.*

An experienced medicine to kill tettars and the itch.

416. Take of flower of brimſtone, ginger, and burnt-alum, of each a like quantity; mix them well, and of this mixture incorporate as much with new unſalted butter, as will bring it to the conſiſtence of an unguent. With this anoint the part affected, as hot as the patient can well endure it, and let it ſtay on all night; the next morning waſh it off with celandine-water. But when the patient goes to bed, he is to take a doſe of ſome alexipharmic medicine, as *Gaſcoign*'s powder, *&c.* to keep the humour from the maſs of blood: he is, alſo, to bathe the part often in a day, with celandine-water. *Tettars*

A remedy almoſt ſpecific for the tooth-ach.

Tooth-ach, and other diſorders in the teeth.

417. Into a quart of red wine, put one dram of alum, and another of acorns, a dram and half of galls, and half a handfull of dry'd red roſe-leaves. Boil to the conſumption of near half, and then take it from the fire; ſtrain it, and diſſolve in it a dram of *Acacia*, cut ſmall; and with this liquor, a little hot, waſh the part ſeveral times in a day. 'Tis alſo excellent to faſten looſe teeth, being uſed in the ſame manner.

An uſeful remedy for the tooth-ach.

418. Let the patient lie on the ear that is oppoſite to the part affected, and into the other ear let fall two or three drops of the freſhly expreſt juice of rue, a little warm, and ſtop the ear lightly with fine black wool, or cotton.

A very ſucceſsful external remedy for the tooth-ach.

419. In the decline of the moon, in *Auguſt*, take the fruit called hipps, with all the fuzzy ſtuff that grows upon it; and wrapping it up in a piece of thin ſarcenet, tie it upon the arm, of the ſame ſide with the part affected, and keep it on as long as there is need.

For the tooth-ach.

420. Take a handfull of red ſage, and a handfull of clary; ſhred them ſmall, beat them, and ſprinkle them with *May* dew; then ſtrain out the juice, put it in a glaſs bottle, and ſet it in the ſun in a window; and when you uſe it, put three drops into a ſpoon, heat it over a candle, and drop it, blood-warm, into the ear; and let the patient eat a cruſt of bread, wet either in broth or poſſet, and chew it upon the teeth that ake.

A good compoſition to ſtop a hollow tooth, and appeaſe the pain.

421. Take two parts of fine ſugar, and one part of black round pepper, both finely powder'd and mixt; put them into a ſilver ſpoon over two or three well-kindled coals: and when the ſugar begins to melt, take off the ſpoon; and whilſt the mixture is yet ſoft, form it into little grains, for ſize and ſhape ſuited to the part affected.

To faſten looſe teeth.

422. Put maſtic, finely powder'd, upon the end of a handkerchief, rub your teeth therewith twice or thrice in a day; and chew maſtic often. Alſo boil pomegranate-flowers with mint or maſtic, in claret wine; and gargle, or waſh your mouth often with it.

A medicine preſcribed to K. Charles I. *to faſten the teeth.*

423. To a pint of ſpring-water put four ounces of brandy; let the patient waſh his mouth with the mixture every morning, and twice or thrice a day beſides; and let him, in the morning, roll for a little while, a bit of roch-alum in his mouth.

An excellent medicine to faſten the teeth in ſcorbutic gums.

424. Take of choice bole-armeniac two drams, choice myrrh one dram, roch-alum crude, half a dram, claret-wine one pint; boil theſe ſoftly for a little while together; and let the patient uſe the ſtrained liquor twice, thrice, or oftener, in a day.

To faſten teeth made looſe by the ſcurvy.

425. Anoint the parts affected with oil of myrrh, made, *per deliquium*, with whites of eggs boil'd hard.

A lotion to faſten the teeth.

426. In a quart of ſpring-water, boil, for a while, one ounce of the beſt *Terra Japonica* in groſs powder; and having filter'd the decoction, keep it cloſe ſtopt for uſe.

A good aſtringent liquor to faſten looſe teeth.

427. In a pint of red wine, infuſe about half an ounce of *Terra Japonica*, till as much as will diſſolve be taken up by the liquor; decant it from the feces, and keep it well ſtopt.

An uſeful liquor to faſten the teeth, and prevent the tooth-ach.

428. To a pint of ſpring-water, put half an ounce of clean ſal-armoniac; and with the ſolution let the patient waſh his mouth from time to time.

An innocent dentrifice.

429. Take maſtic, and dragons-blood, of each a ſufficient quantity; powder them, mix them together, and let the patient uſe them as a dentrifice.

A good and innocent dentrifice.

430. Rub the teeth with fine powder of red coral, two or three times a day; then waſh them with water, in which *Sal Prunella* is diſſolved.

To prevent the tooth-ach, and keep the teeth ſound.

431. Let the patient frequently rub his teeth, moderately, with the aſhes that remain in tobacco-pipes, after ſmoaking; waſhing his mouth with fair water not too cold.

To appeaſe the violent pains of the tooth-ach.

432. Make up a ſcruple of *Pilula Maſtichina*, and half a grain of laudanum, into two or three pills, for the patient to take at bed-time.

For the tooth-ach.

433. Apply a plaiſter of *Caranna*, between the bottom of the ear and the temples, on the ſide where the pulſation of the artery is the moſt manifeſtly felt.

A good medicine for pain of the teeth, proceeding from rheum.

434. Put of the powder of white hellebore, into a clean linen rag, like a nodule, about the bigneſs of a large pea; and let the patient hold it between his teeth, with his head and face ſomewhat inclined, that the rheum may run freely out of his mouth.

For the aching of a hollow tooth.

435. With oil of wax moiſten a little cotton, and thruſt it up into the tooth; letting it lie there till the pain be aſſwaged.

A powerful and experienced topic for a ſore throat.

Throat diſorder'd.

436. Take two new laid eggs, roaſted moderately hard, and the pap of two well roaſted pippins; beat them well together, and add an equal weight of poſſet-curd, made with ale. Having incorporated them all, apply the mixture very warm to the part affected; ſhifting it once in five or ſix hours.

An approved remedy for a ſore throat.

437. Take verjuice of grapes one ounce, honey half an ounce, crude alum a dram and half, ſea-ſalt half a dram; powder the ſalts finely, and incorporate them very well with the liquors into the form of a liniment: in this dip a long feather, and with it touch the part affected, gargling, between whiles, with a mixture of plantain, and red roſe-water.

An external remedy for a ſore throat.

438. Sew live millepedes between the foldings of a piece of linen, and apply them to the throat, in the form of a ſtay, to be kept on all night.

A try'd remedy for a ſore throat.

439. Take bay-ſalt dry'd, and powder'd; put it into the folds of a rag, in a ſufficient quantity to make a ſtay, to be ty'd about the throat; and apply it over night, as hot as the patient can endure it.

For a ſore throat, eſpecially if inflamed.

440. Take a little handfull of the leaves of common mallows, and eight or ten figs; boil theſe for a quarter of an hour in a pint of new milk, and let the patient uſe it very hot and often.

An

An experienced medicine for a ſore throat.

441. Take one dram of *Album Græcum*, burnt to perfect whiteneſs, and with one ounce of honey of roſes, make a linctus, to be very ſlowly let down the throat.

An experienced medicine for a ſore throat.

442. Into the foot of a worſted ſtocking, that has been long worn, put a ſufficient quantity of good ſea-ſalt, well dried, or decrepited; and this ſalt being put in warm, the ſtocking is to be tied about the patient's neck, and kept on all night. If by the next day the diſtemper be not removed, you may apply freſh ſalt, in the ſame ſtocking as before, on the night following.

A try'd medicine for a ſore throat, cauſed by acid humours in the internal parts of it.

443. Boil half a handful of the leaves of common mallows, in a pint of new milk, for half an hour; then run it through a clean cloth, and let the patient uſe it, a little warm, three or four times a day, as a gargle: or elſe let him hold it in his mouth, ſuffering ſome drops to ſlide ſlowly down his throat.

For a ſore throat.

444. Take a piece of greaſie linen-cloth, which, being doubled, may make a bag, in form of a ſtay, to reach from one ſide of the throat to the other, and contain as much matter as may make it an inch thick. This bag being fill'd with common ſalt, is to be heated throughly, and apply'd to the part affected, as warm as the patient can conveniently endure; and when it begins to grow too cold, another like it, and well heated, is to be ſubſtituted in its room: and whilſt this is cooling, the other may be heated, and made ready for uſe; ſo that the part affected be always kept in a conſiderable degree of warmth, for about 48 hours, if the remedy be ſo long needed.

For a ſore throat.

445. Take the white of a new laid egg, by beating reduced into water; and with this mix ſo much conſerve of red roſes, as will bring it to a ſoft maſs; whereof the patient is to let a little bit at a time melt leiſurely in his mouth.

For a ſore throat.

446. Take houſleek, and having lightly beat it in a ſtone mortar, preſs out the juice hard; to this juice put almoſt an equal quantity of virgin-honey; mix them well, and add a little burnt alum, to give it a

diſcernible aluminous taſt: let the patient take this from time to time, with a liqueriſe ſtick.

An experienced medicine for ſore throats.

447. Take of ſcabious-water ſix ounces, of wine-vinegar a ſmall ſpoonfull, of beaten muſtard-ſeed, and of honey, each a ſpoonfull; ſtir and ſhake them very well together; then filter the mixture, and uſe it as a gargle.

For a ſore throat.

448. Make a plaiſter of paracelſus, three or four fingers broad, and long enough to reach almoſt from one ear to the other; apply it to the part affected, ſo that it may touch the throat as much as poſſible.

A gargle for a ſore throat.

449. To four ounces of plantain-water, add three or four ſpoonsfull of red roſe-water, and mix very well with theſe the white of an egg beaten to a glair: ſweeten the mixture with a ſmall ſpoonful of white ſugar-candy, and let the patient uſe it often.

An excellent medicine for tumours in the throat, and ſome other parts.

450. To a quart of new milk, put a handful of mallow-leaves, with as much of the leaves of night-ſhade, ſhred ſmall; let them boil, till the herbs be tender. Then put into the milk as much crumbs of white bread, as being ſtirr'd well with the other ingredients, will bring all to the conſiſtence of a poultis. This is to be ſpread upon a ſtay for the throat, or ſome other thing fitted to the part affected, and to be laid on as hot as the patient can well endure it; and when it begins to grow cold, it is to be ſucceeded by freſh, made very hot, as the caſe ſhall require.

A remedy, almoſt ſpecific, for the thruſh in children.

The thruſh. 451. Mix freſh juice of houſleek with honey enough to make it ſweet, and then add to it as much finely powder'd roch-alum, as will give it a little tartneſs; put ſome of this mixture, with a feather, down the patient's throat, as far as conveniently may be: the part affected ſhou'd alſo be touched once more within an hour after.

For the thruſh in young children, or a ſore mouth.

452. Fill an egg-ſhell with the juice of red ſage, ſet it on hot embers till it boil, and ſkim it whilſt any ſkum ariſes; then take the quantity of a pea of powder'd alum, and half a ſpoonfull of honey, and let this be put in the egg, and boil it a little; and when cold, rub the child's mouth herewith as often as you ſee cauſe.

An

An excellent poultis to ripen tumours.

Tumours.

453. Take eight ounces of figs, two ounces of white-lilly roots, and two ounces of bean-flower; boil theſe together in water, to the conſiſtence of a poultis, to be ſpread thick, and laid warm upon the part; and to be ſhifted as often as it begins to grow dry.

A medicine that cured an obſtinate tumour of the knee.

454. Take a green colewort-leaf, with red veins or ſtreaks, and having cut the ribs flat, and almoſt level to the reſt of the leaf, bruiſe it, and apply it to the part affected, renewing it once or twice a day.

An effectual fomentation for ſwellings, accompany'd with ſharp humours.

455. To a gallon of ſpring-water, put as much dry'd ſage, as will afford a ſtrong decoction; into which, when it firſt grows hot, caſt about two ounces of *Caſtile*-ſoap, and let it diſſolve therein. With this foment the part for a good while together.

An excellent plaiſter to diſcuſs tumours that may be reſolved, and ripen thoſe that it cannot diſſipate.

456. Incorporate with the *Emplaſtrum de Sapone*, about a fourth part of *Balſamum ſulphuris terebinthinatum*, and uſe it as a plaiſter; or in like manner, *Diachylon cum gummi*; renewing it once in two or three days.

A plaiſter to diſcuſs or ripen tumours.

457. Take of yellow wax, frankincenſe, and roſin, of each four ounces; melt them together gently, and being ſtrained, make up the maſs into a roll for uſe.

An excellent medicine for vapours, or fits of the mother.

Vapours.

458. Take ſagapenum, diſſolved in vinegar of ſquills, ſtrain'd through a ſieve, and again thickned; ammoniacum, in like manner prepared, ſteel prepared, myrrh, and the fæcula of bryony, of each half a dram, *Engliſh* ſaffron, caſtor, of each a ſcruple, borax two ſcruples, ſyrup of *Stæchas* a ſufficient quantity; mix, and make pills of a convenient bigneſs to be ſwallowed; of which take three morning and night.

An uſeful plaiſter for the vapours, ſpleen, and ſhortneſs of breath, when 'tis nervous.

459. Take two parts of ſtrained *Galbanum*, and one part of *Aſſa fœtida*, and make thereof a plaiſter, as big as the palm of one's hand; leaving a broad edge quite round: and putting a large piece of cotton in the middle, apply it to the navel.

A rough emetic, by which the venereal diſeaſe has been often cur'd.

Venereal diſeaſe. 460. Take good mercury ſublimate, and *Venice*-treacle, of each one ounce; mix them together, and put them into a quart of ſpring-water; ſet them *in balneo*, to diſſolve in a cloſe veſſel; and of this liquor well ſettled, let the patient take about half a ſpoonful, or a ſpoonful, but never above a ſpoonful and a half, in four ounces of warm ſmall ale, in the morning faſting, and once in the afternoon, or evening; the ſtomach being empty. Every ſecond day intermit, and give a gentle purge.

Againſt a vertigo.

Vertigo. 461. Take of cyprus-roots two ounces, of aniſeed half an ounce; make of them a very fine powder, and give as much as will lie on a ſix-pence, in a ſpoonful of wine, beer, or ale; going to bed.

A ſlow, innocent way of making veſicatories without cantharides.

Veſicatories to make. 462. Put to a handful of crows-foot, about half a ſpoonful of muſtard; and beat them very well together, to the conſiſtence of a poultis, to be ſpread thick, and kept on for twelve or fourteen hours.

A good medicine to raiſe bliſters.

463. Upon half an ounce of powder'd cantharides, put two or three ounces of good ſpirit of wine; let them lie together for four or five days, that the ſpirit may acquire a good tincture; then filter it, and dip into it a piece of linen cloth, ſix or eight times double, and of the figure and ſize deſired. This cloth being throughly wetted, and cover'd with a melilot plaiſter, to keep it on, muſt be applied to the part. At the end of five or ſix hours, you may take off the plaiſter and the linen cloth, and find the bliſter raiſed.

To raiſe a bliſter without cantharides.

464. The ſeed of *Clemmatis Peregrina*, being bound hard upon any part, will, in an hour or two, have an operation, like that of another veſicatory.

A water for ulcers and ſores.

Ulcers. 465. Take a ſolution of *Venetian* ſublimate; and having made, with very good quick-lime, as ſtrong a lime-water as you can, drop this upon the diſſolved ſublimate, till it precipitates no more reddiſh matter: as ſoon as you perceive the liquors act no longer upon one another, pour the mixture into a filter of cap-paper; which, retaining the orange-coloured precipitate, will let paſs an indifferently clear liquor, to be kept ſtopt in a glaſs vial. The part affected may be herewith waſh'd, from time to time; and, if need be, cover'd with double linen cloths, wetted in the ſame.

A famous empirical medicine for a ſtubborn ulcer.

466. Lightly burn to aſhes, the groſs ſtalks on which the red colewort grows, and, with any fit addition, make a cataplaſm, to be apply'd to the ulcer; and ſhift it at reaſonable diſtances of time.

A try'd medicine to make a quick exfoliation of a carious bone.

467. Take the thigh-bone of a man, and having burnt it black, reduce it to a fine powder, to be carefully ſtrewed all over the part to be exfoliated, after ſome drops of chymical oil of ſavin have been employ'd to wet and ſoften the part, and make the powder ſtick well: this done, dreſs it up, and 'twill ſeldom require a third application.

A try'd medicine for an ulcer in the womb.

468. Of true *Bitumen Judaicum*, reduced to very fine powder, let the patient take about a dram at a time, in any proper vehicle, once or twice a day.

An aſtringent liquor, of great uſe in ulcers, and ſome wounds.

469. Boil two drams of choice *Catechu*, or *Japan* earth, in a quart of ſpring-water; pour off the clear, and with it, by injection, or otherwiſe, dreſs the ulcers or wounds.

For outward ulcers.

470. Take the green bark of oak, and chop it all together, both inſide and outſide, into very ſmall pieces; pour thereon good lime-water freſh made, and let it infuſe, till the liquor has acquir'd a deep tincture. With this dreſs the ulcer once or twice a day.

A ſucceſsful water for ulcers and ſores.

471. To a quart of ſpring-water, add one dram of mercury ſublimate, finely powder'd; and when 'tis quite diſſolv'd, drop into the ſolution, ſpirit of ſal-armoniac, till no more will manifeſtly precipitate. Then filter the mixture through cap-paper, and reſerve the precipitate for other uſes. The liquor that paſſes, keep cloſe ſtopt in a glaſs; and when you uſe it, dip linen rags therein, and apply them to the part affected twice or thrice a day.

A ſpeedy remedy for fits of vomiting.

472. Take a large nutmeg, grate off one half of it, and toaſt the flat ſide of the other, till the oily part begin to ouze out; then clap it to the pit of the patient's ſtomach, as hot as he can well endure it, and let him keep it on whilſt it continues warm; and then, if need be, put on another. *Vomiting.*

Emetic drops.

473. In compliance with ſome ingenious phyſicians, and others, who have often employ'd a medicine, that goes under the name of my emetic drops, I ſhall communicate the preparation of them; without preſſing their uſe any otherwiſe, than by declaring, that ſeveral practitioners in phyſic, of differing ſentiments, agree in aſſuring me, they have not yet found any emetic to work ſo effectually, nor with more eaſe and ſafety, than this liquor; which ſome of them prefer, by much, to other antimonial vomits; and eſpecially to the infuſion of *Crocus Metallorum.*

In preparing my vomitive liquor, I have not always employ'd the ſame proportion of the ingredients 'tis made of; nor did I find it neceſſary to be nice in this particular. But the proportion I ſomewhat prefer, is to take two parts of well choſen and finely powder'd antimony, and three parts of ſpirit of wine; which ought to be rather moderately ſtrong, than too much rectified. Theſe are to be diſtill'd together in a glaſs retort, fitted with a large receiver, till there come over a great part of the menſtruum; which will uſually, towards the cloſe, be accompanied with red flowers, that muſt be ſeparated by filtration through cap-paper; and the clear liquor put into a glaſs, not newly waſh'd, but dry on the inſide, to be kept cloſe ſtopt from the air.

The doſe is uſually, to grown perſons, eſpecially at the firſt time, from four or five, to ſeven or eight drops. The vehicle may be a ſpoonfull or two of wine, black-cherry water, or ſpring-water; drinking up the liquor immediately after mixing, becauſe there will ſome precipitation be made; and then taking two or three ſpoonsfull of the ſame vehicle to waſh it down. It uſually begins to work early, and does it without cauſing near ſo much ſtraining as vulgar emetics, and yet makes large evacuations. Having had occaſion to keep long by me ſome vials of theſe emetic drops, I obſerv'd, that in time, there began to ſubſide a white powder, wherein a large part of the vomitive faculty of the medicine may be ſuppos'd to reſide; therefore 'twill be beſt either to employ the liquor ſoon after 'tis made, or to ſhake the vial well, juſt before 'tis adminiſtred.

For ſharpneſs of urine.

Diſorders from the urine. 474. Take of the dry matter that divides the lobes of the kernels of walnuts, beat it to powder; and of this give about half a dram at a time, in a draught of white-wine, or poſſet-drink made with it, or any other convenient liquor.

An excellent emulſion in caſe of ſharpneſs of urine, eſpecially if cauſed by bliſtring plaiſters.

475. Take mallows two handsfull, gum-arabic two drams, barley-water a ſufficient quantity; boil all to a quart; to which add ſweet almonds blanch'd one ounce, of the four greater cold ſeeds, of each two drams. Make an emulſion, ſtrain, and add two ounces of ſyrup of marſh-mallows; and of this drink at pleaſure.

An eaſie diuretic.

476. Peel off the inner ſkin of an egg-ſhell, then beat the ſhell to a very fine powder: give about a ſcruple of it at a time, in any convenient vehicle.

A powerful medicine for the ſtoppage of urine.

477. Fry chervil with a ſufficient quantity of oil of walnuts, and apply a cataplaſm made of it, very hot to the navel; and, if need be, to the *Os pubis*, or ſhare-bone.

For a retention of urine.

478. Fry chervil well with freſh hogs-lard, and lay it very hot upon the patient's navel, and the adjacent parts; ſhifting it, if there be occaſion, once or twice.

An approved medicine to drive the ſtone, and cure ſuppreſſion of urine proceeding from it.

479. Take the roots of wild garlic, by ſome called crow-garlic, wipe them clean, ſtamp them well in a ſtone mortar, and ſtrain out the juice; with which make a moderate draught of good white wine conſiderably ſtrong, and let the patient take it once or twice a day.

For ſharpneſs of urine, obſtruction of the menſes, and their flowing too much, if the diſtemper be not obſtinate.

480. Give about half an ounce at a time, of the newly expreſt juice of ground-ivy, in any convenient vehicle.

An old lithotomiſt's medicine for ſuppreſſion of urine.

481. Give about fifty grains, or one dram, for a doſe, of the *Pulvis Hollandi*; and if the neceſſity be very urgent, you may give from one dram to four ſcruples, or a dram and half; not neglecting in the mean while other proper remedies.

For ſuppreſſion of urine.

482. Give about a ſpoonful, at a time, of bruis'd muſtard-ſeed, in any convenient vehicle.

A medicine almoſt ſpecific for the ſuppreſſion of urine.

483. Infuſe two handsfull of the flowers of *French* lavender, in a good heat, in a pint of brandy; and of this infuſion give a ſmall wine-glaſs full at a time.

A try'd medicine for a ſuppreſſion of urine, that is not very obſtinate.

484. Diſſolve half an ounce of choice *Caſtile* ſoap, in half a pint of white-wine, or ſome appropriated liquor; paſs the ſolution thro' a woollen filter, that the more unctuous parts may reſt behind, and the liquor paſs more clear; put to this five or ſix grains of ſaffron: divide it into two doſes, whereof one is to be given a few hours after the other, if the firſt do not operate well.

An experienced remedy for making bloody urine.

485. Take the waters of the black alder, and of mallows, of each three ounces, ſyrup of comfrey one ounce; mix them, and let the patient take four ſpoonsfull four or five times a day.

A powerful diſſolving ointment for warts and tumors.

For warts. 486. Take *May* butter, and having melted it in a moderate heat, mix with it, by little and little, as much oil of tartar *per deliquium*, as will give it a ſenſible ſtrong taſt.

An empiric's boaſted remedy for the whites.

The whites. 487. Make a ſtrong decoction of the herb ladies-mantle, and let the patient drink of it about half a pint every morning faſting; and if the caſe be urgent, make an injection of the ſame plant, boiled very tender, and let the patient make uſe of it from time to time.

An excellent remedy for the whites in women.

488. After due purging give two, three, or four grains of laudanum; and inject, four or ſix times a day, the following.

Take ſpring-water two quarts, white vitriol, and roch-alum, of each two ounces: powder, mix, and diſſolve. Let the liquor ſettle, and uſe only the clear.

A powerful medicine for the whites.

489. Shred into a pottle of ale, two ounces of white iſing-glaſs, and in a looſely ſtopt veſſel, let the liquor ſimmer till about half is waſted; ſtrain the reſt, and give of it two or three ounces at a time, once or twice a day.

For a whitlow.

490. Beat ſhell-ſnails very well, with a convenient quantity of parſley, to be applied warm to the affected part, and ſhifted two or three times a day. *Whitlows.*

A try'd medicine for a whitlow.

491. Beat houſe-ſnails, ſhells and all, in a ſtone-mortar, till they be reduced to the conſiſtence of a cataplaſm; which apply ſomewhat warm to the part affected, and keep it on for ſixteen or twenty four hours, renewing it occaſionally.

An excellent remedy for whitlows on the fingers.

492. Take a reddiſh or blackiſh ſnail, of the ſort that has no ſhell, and having beaten it in a ſtone mortar to the conſiſtence of a poultis, apply it to the part affected; renewing it once or twice, after it has been kept on for ſome hours.

For women in labour, to bring away the child.

493. Let the patient take about one dram of choice powder of myrrh, in a draught of *Rheniſh* wine or ſack; or ſome other more temperate vehicle. *Womb-medicines.*

An often proved remedy to cleanſe the womb of a lying-in-woman.

494. With the juice of ſheeps-ſorrel, and ſome of the ſtrong infuſion of the ſame herb, made in water, and a ſufficient quantity of ſugar, make a ſyrup: of which let the patient take about a ſpoonfull twice or thrice a day.

An experienced medicine to cleanſe the womb.

495. Take a large white onion, cut it into ſmall pieces, and boil it in a pint of water, or leſs, as if it were to be dreſſed for eating. And of this decoction give ſeven or eight ounces for a doſe, mix'd with about half an ounce of freſh oil of walnuts.

To cleanſe the womb, eſpecially after child-bearing.

496. Take a large white onion, about four ounces in weight, and boil it in about a pint of water, with any thing fit to make a very thin broth, till a third part, or more, of the liquor be conſumed: of this broth, which may be made a little palatable with nutmeg, *&c.* the patient is to take ſix or eight ounces, twice or thrice a day.

For a Prolapſus Uteri.

497. Apply to the patient's navel a pretty large cupping-glaſs; but let it not ſtay on above a quarter of an hour, for fear of injuring the part it covers.

A good vehicle for ſeveral remedies, being of itſelf uſeful againſt the jaundice, and worms in children.

Remedies for worms. 498. The diſtill'd water of the husks of walnuts, is a very good vehicle in ſeveral diſeaſes; particularly in the jaundice: 'tis a cordial, and exceeding proper to be mixt with juleps in fevers. 'Tis, alſo, an excellent medicine againſt the worms, eſpecially for children.

An approved medicine againſt the worms in children.

499. Infuſe one dram of clean quick-ſilver all night, in about two ounces of the ſtill'd water of goats-rue; afterwards ſtrain and filter it. This quantity is to be given for one doſe.

An experienced ointment for the worms in children.

500. Take rue, wormwood, and ſavin, of each a ſufficient quantity; and with *May* butter, or freſh hogs-lard, boil the herbs ſoftly, till you have brought the mixture to be very green. Then ſtrain it, and put it up for uſe; when you employ it, firſt anoint with it the pit of the ſtomach, and part of the cheſt; and after a while rub it pretty well upon, and all about the navel.

A powerful remedy for freſh wounds.

For wounds. 501. With the juice of celandine, dreſs recent wounds and cuts, inſtead of a balſam.

A balſam to ſtench the blood of freſh wounds, and to heal them ſpeedily.

502. Take good *Venice* turpentine, and in a limbec diſtil off a large part of it with a very moderate fire, till there remains a thick ſubſtance, of a liquid and balſamic conſiſtence; which is the ſubſtance we ſeek for, and ſhould be apply'd as a balſam.

An excellent wound-drink.

503. Take harts-tongue, liver-wort, wood-bugle, wood-ſage, wood-betony, ſouthernwood, wormwood, alehoof, bugloſs, ſcabious, ribwort, white-bottles, mugwort, comfrey, mint, agrimony, ſtrawberry and violet-leaves, cinquefoil, daiſie-leaves, roots, and flowers, wild honey-ſuckles, wild angelica, avens, plantain, clowns, wound-wort, hawthorn-buds, oak-buds, and bramble-buds.

Gather the herbs in *May*, or as many of them as can then be had; and the buds in *March*, as ſoon as ever they appear; meaſure them, and take equal quantities of them, dry them ſeverally in the ſhade; and, when throughly dried, put them up in bags, and ſo keep them for uſe.

Then take one gallon of ſpring-water, one pottle of the beſt white-wine, and two good handsfull of all the herbs, mixed well together, being dried; but if green, then one good handfull of each. Boil them in a pipkin to the conſumption of half; then ſtrain it out, put to the liquor a quart of honey, let it boil again, skim it; and when cold, put it up into bottles, ſtopt very cloſe. Let the patient drink morning and evening about a quarter of a pint, faſting for one hour or two after. The liver-wort is beſt to be put in green. If you uſe this for any ſore or ulcer in the body, lay a ſearcloth or plaiſter to it, of *Unguentum Apoſtolorum*, *Emplaſtrum de minio*, or a plaiſter of honey and wax.

This drink is effectual in ſores, old or new, womens ſore breaſts, putrefied bones, cauſing them to ſcale; 'tis good for any ach in the ſtomach, it hath cured the king's evil, and cauſed bullets in the fleſh to come out, tho' they had long continued there.

An often try'd digeſtive, to be uſed inſtead of baſilicon.

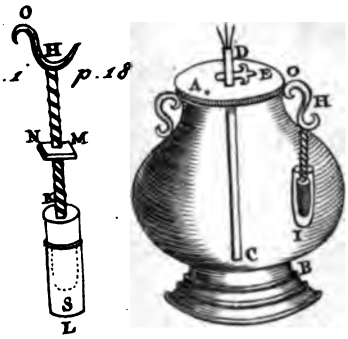
504. Take two ounces of good *Venice* turpentine, and incorporate very well with it the yolks of two freſh eggs, and add to it a little ſpirit of wine occaſionally; with this dreſs morning and evening, laying it on thicker, if the part be near ſome nerve, and thinner, if it be fleſhy or moiſt.

An excellent balſam for any green wound.

505. Take oil of St. *John*'s-wort, and *Venice* turpentine, of each a like quantity; ſet them over the fire in a gentle heat, for half an hour, that they may incorporate.

The End of the Third Volume.

Fig. 1 p. 18



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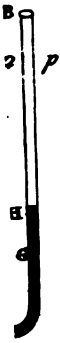
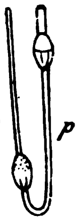


Fig: 3 p: 48



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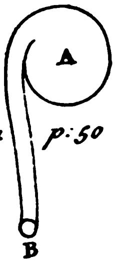

A GENERAL INDEX TO THE THREE VOLUMES.

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